AMERICAN ACADEMY OF OTOLARYNGOLOGY–HEAD AND NECK SURGERY FOUNDATION

Otolaryngology–Head and Neck Surgery
2017, Vol. 156(3) 442–455

DOI: 10.1177/0194599816683915
http://otojournal.org
SAGE

Postoperative Bleeding and Associated Utilization following Tonsillectomy in Children: A Systematic Review and Meta-analysis

David O. Francis, MD, MS[1], Christopher Fonnesbeck, PhD[2], Nila Sathe, MA, MLIS[3], Melissa McPheeters, PhD, MPH[3], Shanthi Krishnaswami, MBBS, MPH[4], and Sivakumar Chinnadurai, MD, MPH[1]

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

Objective. To assess posttonsillectomy hemorrhage (PTH), associated nonoperative readmissions/revisits, and reoperations in children.

Data Sources. MEDLINE, EMBASE, and the Cochrane Library.

Review Methods. Two investigators independently screened studies against predetermined criteria and extracted key data. Investigators independently assessed study risk of bias and the strength of the evidence of the body of literature. We calculated unadjusted pooled estimates of PTH frequency and conducted a Bayesian meta-analysis to estimate frequency of primary and secondary PTH and PTH-associated reoperation and revisits/readmissions by partial and total tonsillectomy and surgical approach.

Results. In meta-analysis, the frequency of primary and secondary PTH associated with total and partial tonsillectomy was <4% for any technique and with overlapping confidence bounds. Pooled frequencies of PTH were also <5% overall (4.2% for total tonsillectomy, 1.5% for partial tonsillectomy) in comparative studies. Fewer PTH episodes occurred with tonsillectomy for obstructive sleep-disordered breathing than for throat infection. In meta-analysis, frequency of PTH-associated nonoperative revisits/readmission or reoperation ranged from 0.2% to 5.7% for total tonsillectomy and from 0.1% to 3.7% for partial tonsillectomy. At least 4 deaths were reported in case series including 1,778,342 children.

Conclusions. PTH occurred in roughly 4% of tonsillectomies in studies included in this review. Although studies typically did not report bleeding severity or amount, relatively few episodes of PTH necessitated reoperation for hemostasis. Nonetheless, tonsillectomy is not without risk of harm. Frequency of PTH across techniques was similar; thus, we cannot conclude that a given technique is superior.

Keywords

tonsillectomy, adenotonsillectomy, posttonsillectomy hemorrhage, postoperative bleeding

Received October 24, 2016; accepted November 22, 2016.

Each year in the United States, >500,000 children aged <15 years undergo tonsillectomy or adenotonsillectomy (hereafter, tonsillectomy), making these among the most common operations performed on children.[1] Primary indications for tonsillectomy are obstructive sleep apnea and recurrent throat infections. While generally considered safe and straightforward, tonsillectomy has risks that vary in frequency and severity. Owing

[1]Department of Otolaryngology, Vanderbilt University Medical Center, Nashville, Tennessee, USA
[2]Department of Biostatistics, Vanderbilt University Medical Center, Nashville, Tennessee, USA
[3]Department of Health Policy, Vanderbilt Evidence-Based Practice Center, Institute for Medicine and Public Health, Vanderbilt University Medical Center, Nashville, Tennessee, USA
[4]Vanderbilt Evidence-Based Practice Center, Institute for Medicine and Public Health, Vanderbilt University Medical Center, Nashville, Tennessee, USA

This manuscript was derived from a systematic review conducted by the Vanderbilt Evidence-Based Practice Center ("Tonsillectomy for Obstructive Sleep-Disordered Breathing or Recurrent Throat Infection in Children"), which will be published in full on the Agency for Healthcare Research and Quality website.

The authors of this report are responsible for its content. Statements in the report should not be construed as endorsement by the Agency for Healthcare Research and Quality or the US Department of Health and Human Services.

Corresponding Author:
David O. Francis, MD, MS, Department of Otolaryngology, Vanderbilt University Medical Center, 1215 21st Avenue South, Medical Center East, Suite 7409, Nashville, TN 37232, USA.
Email: david.francis@vanderbilt.edu

Table 1. Inclusion Criteria.

Category	Criteria
Population	Children with obstructive sleep-disordered breathing or recurrent throat infection undergoing tonsillectomy, aged 3-18 y, inclusive
Intervention	Tonsillectomy, adenotonsillectomy, or tonsillotomy (partial removal of tonsil) with any surgical approach (eg, coblation, laser, cold dissection)
Design	Comparative studies (randomized controlled trials, prospective or retrospective cohort studies with comparison groups, nonrandomized trials, case-control studies); database or registry studies or case series with at least 1000 participants
Other	Original research Publication language: English Publication year: January 1980–June 2016 Risk of bias: low or moderate (high risk of bias included in meta-analyses after sensitivity analyses) Sufficiently detailed methods and results to enable data extraction Reports outcome data by target population or intervention

to the robust vascular supply of the tonsils, the primary risk of this operation is posttonsillectomy hemorrhage (PTH), which can range from blood-tinged mucus to life-threatening bleeding. Definitions and classification of PTH and PTH severity vary across the tonsillectomy literature, as do methods for capturing instances of PTH.[2-4] To mitigate PTH risks, surgeons are continually refining surgical approaches, comparing bleeding across various surgical techniques, and investigating patient and disease factors that may influence these risks.

The breadth of the tonsillectomy literature makes a comprehensive understanding of the overall and technique-related risks difficult. Clear, evidence-based risk estimates are critical as families weigh the benefits and harms of undergoing this surgery. Understanding the relative risk of bleeding related to tonsillectomy for specific indications, for partial (eg, tonsillotomy, intracapsular tonsillectomy) vs total tonsillectomy, and for tonsillectomy technique (eg, cold, electrocautery) for children would aid clinicians and caregivers in making care decisions.

In this systematic review and meta-analysis, we examined published evidence regarding PTH among children with obstructive sleep-disordered breathing (OSDB) or recurrent throat infections. This review is a component of an Agency for Healthcare Research and Quality–commissioned comparative effectiveness review of tonsillectomy in children conducted by the Vanderbilt Evidence-Based Practice Center. The full comparative effectiveness review (which addresses broader questions of effectiveness and safety) and review protocol (PROSPERO registry CRD42015025600) are available at http://www.effectivehealthcare.ahrq.gov.

Methods

Search Strategy and Study Selection

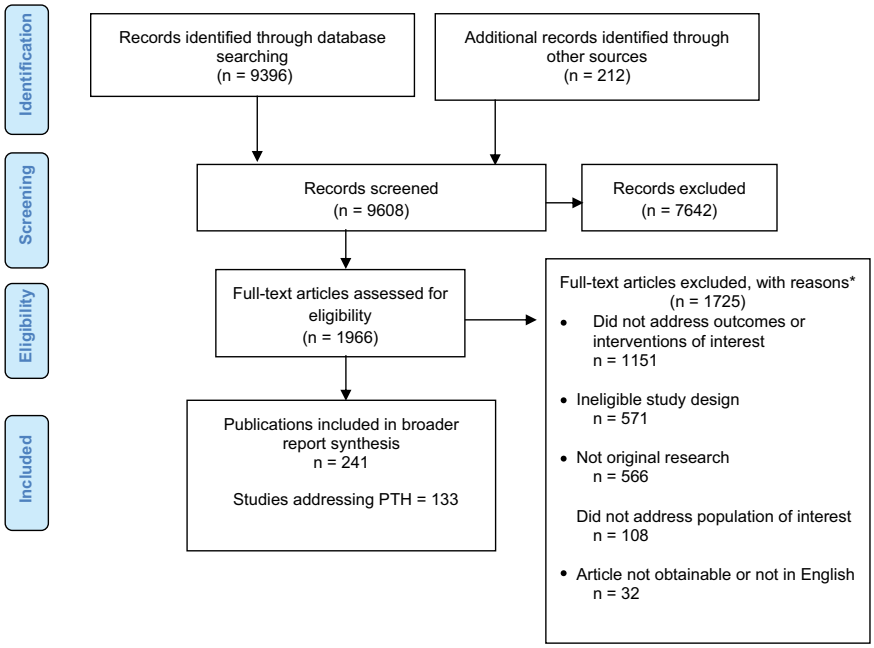
We searched the MEDLINE database via PubMed, EMBASE, and the Cochrane Library from January 1980 to June 2016 using a combination of controlled vocabulary and key terms related to tonsillectomy and OSDB or recurrent throat infections (eg, tonsillectomy, adenotonsillectomy, obstructive sleep apnea, streptococcal pharyngitis). We also hand-searched the reference lists of included articles and recent reviews addressing tonsillectomy in children to identify potentially relevant articles. We used the broader term OSDB after extensive discussions with a multidisciplinary expert panel and key informants (including pediatric otolaryngologists and pediatric sleep specialists) who agreed that this term would be inclusive of disorders ranging from simple snoring to OSA, as each can have significant quality-of-life and health consequences.

We also developed inclusion criteria in consultation with an expert panel of clinicians and researchers (**Table 1**). We included comparative study designs (eg, randomized controlled trials, prospective or retrospective cohort studies) to address effectiveness and harms outcomes. We also included case series or database or registry studies with at least 1000 children to evaluate rates of PTH, PTH-associated revisits or readmissions, and PTH-associated reoperation. We considered PTH to comprise any report of posttonsillectomy bleeding, including the entire of range of bleeding as reported in each study, from bloody sputum to frank bleeding requiring readmission or reoperation.

Data Extraction and Analysis

One investigator extracted data regarding study design, descriptions of study populations, intervention and comparison groups, and baseline and outcome data using a standardized form. A second investigator independently verified the accuracy of the extraction and revised as needed.

To fully account for PTH, readmission, and reoperation, we compiled all comparative studies and examined the frequency of harms by study arm in unadjusted analyses, then reviewed data in case series and database and registry studies. We present the data obtained from comparative studies that had low or moderate risk of bias, followed by the case series and database studies (low or moderate risk of bias), and comment on their consistency. Finally, we conducted Bayesian mixed effects arm-based meta-analyses to assess the influence of different surgical procedures and the effect of partial and total tonsillectomy on the occurrence of PTH-related outcomes following surgery. Sensitivity analyses that estimated the effects of including high-risk-of-bias studies in our analyses suggested no systematic effects of these studies; thus, we retained them in meta-analyses.



*Numbers do not tally as studies could be excluded for multiple reasons.
Abbreviations: n = Number.

Figure 1. Disposition of studies identified for this review.

Assessment of Study Risk of Bias

Two investigators independently evaluated the risk of bias (methodologic quality) of studies using prespecified questions appropriate to each study design to assess risk of bias of randomized controlled trials and observational studies.[5] Senior reviewers resolved discrepancies in risk-of-bias assessment through discussion to reach consensus.

Assessment of Strength of Evidence

Strength of the evidence reflects the confidence that we have in the stability of treatment effects in the face of future research.[6] The degree of confidence that the observed effect of an intervention is unlikely to change—the strength of the evidence—is presented as insufficient, low, moderate, or high. Assessments are based on consideration of 5 domains: study limitations, consistency in direction of the effect, directness in measuring intended outcomes, precision of effect, and reporting bias. We determined the strength of evidence separately for major intervention-outcome pairs using a prespecified approach described in the full review.[7]

Results

Overview of Included Studies

Our searches (conducted for the broader systematic review[7]) identified 9608 citations, of which 87 comparative studies (reported in multiple publications) met inclusion criteria and reported PTH data, which included all forms of bleeding (**Figure 1**). PTH may have been reported as primary (generally defined as occurring within 24 hours of surgery), secondary (generally defined as occurring >24 hours postoperatively), or at an undefined or unspecified time.[8-108] Seventy-three studies contributed data to the meta-analysis (66 randomized controlled trials,* 6 nonrandomized trials,[24,35,37,45,48,94] and 1 prospective cohort study[70]). The resulting subset of studies included the following tonsillectomy techniques: cold dissection, electrocautery, coblation, harmonic scalpel, laser, molecular resonance, thermal welding, and microdebrider.

In addition, we sought PTH reported in case series and database analyses to determine whether the frequency supported findings in the comparative literature and to assess harms in larger study populations. We identified 46 unique database or registry studies or case series with ≥1000 children (reported in multiple papers) addressing PTH.[3,4,123-176]

Unadjusted PTH-Related Outcomes in Comparative Studies

Total Tonsillectomy. Fifty-eight unique comparative studies (105 arms) reported on postoperative PTH.† The 6299 children across studies who were treated with total tonsillectomy experienced 265 episodes (4.2%) of PTH (**Table 2**). PTH ranged from parent-reported bleeding that did not require accessing clinical care to reoperation for hemostasis. In all, 33 were primary (1.3%; typically occurring within 24 hours of tonsillectomy); 166 were secondary (4.8%; occurring >24 hours posttonsillectomy); and for 66, timing was not specified (2.7%). Sixty-eight children required reoperation to control

*References 19, 20, 23, 25, 27, 29, 33, 34, 36, 38-41, 43, 44, 46, 47, 49, 50, 52-59, 62-64, 67, 71, 72, 74-79, 81-84, 88-92, 95, 101-105, 108-122

†References 8-15, 19, 20, 23, 25, 27, 33-41, 43-47, 50-59, 62-64, 67, 70-79, 81-84, 88, 89, 91, 92, 94-98, 101, 102, 106-108, 177

Table 2. Unadjusted PTH-Related Outcome Rates in Study Arms Evaluating Total Tonsillectomy.[a]

Technique (Arms, n)	n	PTH	Primary PTH	Secondary PTH	Unspecified PTH	Revisits / Readmissions for PTH	Reoperations for PTH
All arms (105)	6299	265 (4.2)	33 (1.3)	166 (4.8)	66 (2.7)	80 (3)	68 (2.2)
Electrocautery (29)	1668	82 (4.9)	5 (0.37)	62 (6.3)	15 (2.3)	36 (5)	21 (2.6)
Cold dissection (34)	1904	72 (3.8)	6 (0.54)	49 (4)	17 (2.7)	9 (1.6)	19 (2.3)
Coblation (19)	728	23 (3.2)	3 (2.1)	7 (2.4)	12 (2.7)	2 (1.1)	4 (2.5)
Unspecified/ other (5)	748	25 (3.3)	9 (3.1)	NR	16 (3.5)	8 (2)	10 (2.3)
Molecular resonance (5)	466	4 (0.86)	0 (0)	4 (1.22)	0 (0)	1 (0.23)	1 (0.31)
Harmonic scalpel (5)	397	45 (11.3)	1 (0.63)	38 (11.3)	6 (9.8)	15 (5.5)	9 (2.8)
Thermal welding (4)	199	5 (2.5)	0 (0)	5 (2.96)	0 (0)	NR	1 (0.96)
Laser (4)	189	10 (5.3)	9 (11.4)	1 (0.91)	NR	9 (11.4)	3 (2.8)

Abbreviations: NR, not reported; PTH, posttonsillectomy hemorrhage.
[a]Values are presented as n (%). Percentages for primary, secondary, and unspecified PTH; readmissions/revisits; and reoperations reflect the number of each instance of bleeding or reencounter divided by the total number of patients in the studies reporting such data, not in the total number of participants across all studies in a given row.

Table 3. Unadjusted PTH-Related Outcome Rates in Study Arms Evaluating Partial Tonsillectomy.[a]

Technique (Arms, n)	n	PTH	Primary PTH	Secondary PTH	Unspecified PTH	Revisits / Readmissions for PTH	Reoperations for PTH
All arms (18)	599	8 (1.5)	0 (0)	2 (1.6)	6 (1.4)	5 (1.8)	1 (0.64)
Microdebrider (5)	252	3 (1.2)	NR	NR	3 (1.2)	3 (1.5)	NR
Coblation (6)	169	4 (4.2)	0 (0)	2 (6.3)	2 (2.2)	2 (2.8)	0 (0)
Cold dissection (4)	124	1 (0.81)	0 (0)	0 (0)	1 (1.4)	NR	1 (1.1)
Laser (3)	54	0 (0)	0 (0)	0 (0)	0 (0)	NR	NR

Abbreviations: NR, not reported; PTH, posttonsillectomy hemorrhage.
[a]Values are presented as n (%). Percentages for primary, secondary, and unspecified PTH; readmissions/revisits; and reoperations reflect the number of each instance of bleeding or reencounter divided by the total number of patients in the studies reporting such data, not in the total number of participants across all studies in a given row.

PTH (2.2%), and 80 had nonoperative revisits or readmissions for PTH (3.0%).

Children who underwent tonsillectomy with harmonic scalpel had the highest frequency of PTH (11.3%), although few children underwent this procedure (n = 397). Few children had laser tonsillectomy (n = 189), with 5.3% experiencing PTH. Frequencies were similar among more commonly used techniques: cold dissection had a frequency of 3.8%; electrocautery, 4.9%; and coblation, 3.3%. The overall frequency of nonoperative visits/readmissions for PTH was 3.0% (range, 0.23%-11.4% across modalities). **Table 2** outlines data for each technique in each study arm.

Partial Tonsillectomy. The overall PTH frequency for partial tonsillectomy reported in arms of 16 studies was 1.5% (**Table 3**).[‡] Primary and secondary PTH was observed in 0% and 1.6% of children overall, respectively. Nonoperative revisits/readmissions for PTH occurred in 1.8% of cases, while reoperation to control bleeding was performed in 0.64% of children who had undergone partial tonsillectomy. Across surgical techniques, frequency was highest for partial coblation tonsillectomy (4.2%). No PTH was associated with laser approaches, but few small studies (n = 54 children total) assessed this modality.[29,99,100]

PTH by Indication. Across all techniques and types of tonsillectomy (partial or total), the overall unadjusted frequency of PTH was 1.9% (**Table 4**) for children with OSDB. The overall frequency was higher in children with throat infection (3.7%). Primary PTH was similar between throat infection and OSDB (0.58% vs 0.41%), while secondary PTH, nonoperative revisit/readmission, and reoperation were higher among children with throat infection (**Table 4**).

Meta-analysis Results

Total Tonsillectomy. Frequency of primary PTH associated with total tonsillectomy in the meta-analysis was similar among modalities, with overlapping confidence bounds (**Table 5**). Electrocautery and harmonic scalpel were associated with a

[‡]References 25, 29, 39, 47, 49, 50, 53, 56, 58, 63, 81, 88, 91, 99, 100, 103-107

Table 4. Unadjusted PTH-Related Outcome Rates by Indication in Study Arms Evaluating Total or Partial Tonsillectomy.[a]

Indication (Arms, n)	n	PTH	Primary PTH	Secondary PTH	Undefined PTH	Revisits / Readmissions for PTH	Reoperations for PTH
OSDB (28)	1219	22 (1.9)	2 (0.41)	11 (2.1)	9 (1.1)	8 (1.4)	3 (0.85)
Throat infection (34)	1764	88 (5)	12 (1.8)	64 (6.2)	12 (2.3)	29 (3.4)	10 (1.6)

Abbreviations: OSDB, obstructive sleep-disordered breathing; PTH, posttonsillectomy hemorrhage.
[a]Values are presented as n (%). Percentages for primary, secondary, and unspecified PTH; readmissions/revisits; and reoperations reflect the number of each instance of bleeding or reencounter divided by the total number of patients in the studies reporting such data, not in the total number of participants across all studies in a given row.

Table 5. Rates of PTH and PTH-Associated Readmissions or Revisits after Total Tonsillectomy.[a]

Technique	Primary PTH	Secondary PTH	Readmission	Reoperation
Overall (across all techniques)	0.5 (0.1-1)	2.9 (1.5-4.3)	1.8 (0.4-3.3)	1.6 (0.9-2.3)
Cold	0.7 (0.1-1.5)	3.3 (1.9-5.3)	2.7 (0.7-4.9)	1.3 (0.5-2.1)
Electrocautery	0.6 (0-1.5)	4.2 (2.4-6.5)	2.9 (0.7-5.3)	1.2 (0.5-1.9)
Coblation	1.1 (0-3.0)	2.3 (0.7-4.4)	1.4 (0.1-3.3)	1.2 (0.3-2.4)
Harmonic scalpel	1.0 (0-3.3)	4.3 (1.8-7)	1.5 (0.2-3.1)	3.9 (1.6-6.9)
Laser	2.2 (1.0-5.8)	1.2 (0-3.4)	5.7 (0.7-12.6)	5.2 (0.2-13.7)
Molecular resonance	0.6 (0-2.5)	1.1 (0.2-2.4)	0.2 (0-0.6)	0.2 (0-0.5)
Thermal welding	0.5 (0-2.1)	3.6 (0.5-7.5)	2.7 (0-12.7)	0.8 (0-2.4)

Abbreviation: PTH, posttonsillectomy hemorrhage.
[a]Values are presented as % (95% Bayesian credible interval).

higher frequency of secondary PTH (occurring >24 hours post-procedure), with estimates of 4.2% to 4.3% and wide 95% Bayesian credible intervals (BCIs). Nonoperative readmissions or revisits for PTH ranged from 0.2% to 6% and reoperation for hemostasis from 0.2% to 5%. Although laser tonsillectomy was associated with the highest estimated risk of readmission/revisit (5.7%, 95% BCI: 0.7%-12%) and reoperation (5.2%, 95% BCI: 0.2-13.7), the confidence bounds were wide.

Partial Tonsillectomy. Primary PTH associated with partial tonsillectomy was <4% regardless of technique, with secondary bleeding ≤3%. Data on revisits/readmissions and reoperations were sparse; thus, confidence bounds are very wide, and it is difficult to predict frequencies with certainty (**Table 6**).

PTH by Indication. As in unadjusted analyses, lower frequencies of primary and secondary PTH were associated with OSDB as the indication for either partial or total tonsillectomy (**Table 7**). The frequency of primary PTH after total tonsillectomy was 0.3% for children with OSDB (95% BCI: 0%-0.9%) and 1.8% when recurrent throat infection was the indication (95% BCI: 0%-5.9%). Primary PTH frequency after partial tonsillectomy in children with OSDB was 1.2% (95% BCI: 0%-4.1%).

Few studies considered partial tonsillectomy for recurrent throat infection, so sample sizes were smaller and estimates imprecise. Moreover, partial tonsillectomy involves leaving a cuff of tonsillar tissue, which is often accompanied by some mild oozing that is felt to be self-limited and not cauterized. Thus, the risk of minor PTH may be higher with this approach. As noted, this estimate of PTH frequency is imprecise, with wide credible intervals ranging from 0% to 28.7%.

Case Series and Database Analyses. Overall, 2.1% of children in large case series or database studies experienced a PTH episode (**Table 8**), a rate lower than that reported in comparative studies (4.2%). Comparative studies were typically prospectively conducted, which may have more accurately captured PTH episodes. Case series and database studies also had much larger sample sizes (>1000 children), which may account for the difference in rates.

Overall, few children required nonoperative revisits/readmissions or reoperation for PTH, 1.3% and 0.78%, respectively. Case series and database studies infrequently specified the surgical technique or indication for tonsillectomy. In those studies that did report technique, total coblation tonsillectomy (4%) was associated with the highest frequency of total PTH (**Table 8**). Few case series or database studies reported indication. In 2 study arms reporting such data, OSDB as the indication for surgery was associated with a 1.4% frequency of PTH overall, and throat infection was associated with a 4.6% frequency.

At least 4 deaths were reported across 4 case series or database studies reporting mortality.[134,141,172,174,175,178] In 1 study, a 10-year old child with muscular dystrophy, among other comorbidities, died from suspected ventricular fibrillation 1 month after tonsillectomy[172]; investigators did not consider the death related to surgery. In another, a 42-month-old child with recurrent PTH died from bleeding-related shock after he

Table 6. Rates of PTH and PTH-Associated Readmissions or Revisits after Partial Tonsillectomy.[a]

Technique	Primary PTH	Secondary PTH	Readmission	Reoperation
Overall (across all techniques)	1.7 (0-4.6)	0.4 (0-1.2)	0.7 (0-1.9)	0.7 (0-1.7)
Cold	1.5 (0-4.7)	2.3 (1-5.9)	3.7 (0.1-10.3)	0.5 (0-1.3)
Electrocautery	1.5 (0-5.3)	3 (0.2-8)	4 (0.2-12.3)	0.4 (0-1.2)
Coblation	1.5 (0.1-4.2)	1.4 (1-3.5)	1.4 (0.1-3.1)	0.4 (0-1.1)
Harmonic scalpel	2.2 (0-8.3)	3 (1-7.9)	2.1 (0-6.3)	1.4 (0-3.9)
Laser	3.9 (0-12.9)	0.7 (0-2.4)	7.3 (0.2-20.7)	1.8 (0-5.4)
Molecular resonance	1.4 (0-6)	0.8 (0-2.3)	0.3 (0-1)	0.1 (0-2)
Thermal welding	1 (0-4.5)	2.6 (0-7.7)	3.4 (0-17)	0.3 (0-1)

Abbreviation: PTH, posttonsillectomy hemorrhage.
[a]Values are presented as % (95% Bayesian credible interval).

Table 7. Rates of PTH and PTH-Associated Readmissions or Revisits by Indication and Approach.[a]

Approach/Indication	Primary PTH	Secondary PTH	Readmission	Reoperation
Total tonsillectomy				
OSDB	0.3 (0-1.0)	2.2 (0.3-4.8)	0.1 (0-2.7)	1.3 (0.3-2.7)
Recurrent throat infection	1.7 (0-5.6)	3.7 (0.9-7.1)	2.1 (0-6.6)	1.6 (0.2-4)
Partial tonsillectomy				
OSDB	1.3 (0-4.3)	0.3 (0-1.2)	0.4 (0-1.4)	0.6 (0-1.6)
Recurrent throat infection	7.8 (0-28.7)	0.6 (0 -2.1)	1.0 (0-3.5)	0.9 (0-2.8)

Abbreviations: OSDB, obstructive sleep-disordered breathing; PTH, posttonsillectomy hemorrhage.
[a]Values are presented as % (95% Bayesian credible interval).

was discharged 6 days posttonsillectomy.[174,175,178] Another database study reported 2 deaths (out of 36,221 tonsillectomies, 0.006%) but did not report cause of death.[141] Finally, a fourth database study did not report exact numbers or causes of death but compared tonsillectomy complications occurring in different hospital types (teaching or nonteaching children's hospitals, nonteaching hospitals)[134]: in each hospital type, ≤10 deaths occurred, but the study does not report specific figures.

Strength of the Evidence

We considered only data from meta-analyses and comparative studies in our assessment of the strength of the evidence. Strength of evidence is high for a low frequency of PTH and PTH-associated utilization (readmissions or revisits) with both partial and total tonsillectomy.

Discussion

PTH is a critical risk associated with tonsillectomy. Clinicians and researchers cite variable rates based on personal experience and/or understanding of the literature. This systematic review and meta-analysis synthesize the available evidence to provide population-level estimates of PTH and related health utilization (ie, need for revisits/readmissions or reoperation). Our study found that PTH and associated utilization after tonsillectomy occurred in <5% of children and that readmission or reoperation rates for PTH were typically <4%. While these rates are comparatively low, any bleeding may be serious and is certainly troubling to patients and their caregivers. Severity of bleeding and repeat bleeding may be more predictive of serious morbidity than simple frequency, but our ability to assess this was limited. Some studies have suggested that repeated PTH episodes can be considered warning signs of impending serious PTH[3,179-181]; however, we could not assess timing of PTH beyond primary and secondary, as few studies reported whether children experienced >1 episode. Nonetheless, severity of bleeding directs management decisions—specifically, whether a child is seen and discharged from the emergency department, admitted for observation, or undergoes surgical hemostasis, which presumably would represent the most severe bleeding episodes. Several factors that may influence PTH are reviewed in turn.

Factors Influencing PTH

Technique Comparison. Tonsillectomy technique has long been discussed as a potential mitigating factor in reducing PTH risk. Otolaryngologists typically become facile with a particular technique (or techniques) and use it preferentially. This preference may derive from training environment and years in practice among other sources.[182,183] A significant literature is dedicated to comparing various surgical techniques. Overall, unadjusted PTH rates among comparative studies (ie, including a treatment and comparison group) were similarly low among common techniques: cold dissection (3.8%) electrocautery (4.9%), and coblation (3.3%). In meta-analysis, electrocautery and harmonic scalpel were associated with higher

Table 8. Rates of PTH Reported in Case Series or Database Studies.

Technique or Indication (Arms, n)	n	Total PTH, n (%)	Primary PTH, n (%)	Secondary PTH, n (%)	Unspecified PTH, n (%)	Nonoperative Revisit / Readmission for PTH, n (%)	Reoperation for PTH, n (%)
All studies	1,154,686	23,661 (2.1)	1005 (1.2)	1586 (2.1)	21,070 (1.97)	8451 (1.3)	4797 (0.78)
Technique							
Total electrocautery (5)	16,938	605 (3.6)	62 (0.7)	330 (3.6)	213 (2.8)	216 (2.3)	65 (0.6)
Total cold (10)	39,416	984 (2.5)	567 (2.5)	257 (1.9)	160 (1.8)	208 (1.1)	199 (0.9)
Coblation (3)	6852	275 (4.01)	5 (0.3)	82 (4.3)	188 (3.8)	NR	111 (1.62)
Other techniques (26)	21,532 (2.04)	21,420 (1.98)	371 (0.9)	917 (2.2)	20,244 (1.95)	8027 (0.74)	4422 (0.41)
Indication							
OSDB (4)	44,318	597 (1.4)	149 (1.4)	183 (1.6)	265 (0.80)	155 (1.4)	214 (0.50)
Throat Infection (3)	4056	187 (4.6)	NR	150 (6.3)	37 (2.2)	NR	2 (0.13)

Abbreviations: NR, not reported; PTH, posttonsillectomy hemorrhage.

rates of secondary PTH (occurring >24 hours postprocedure), with estimates of 4.2% to 4.3%. However, confidence intervals around these estimates were wide, indicating relative imprecision based on limited available data. Despite this finding, the differences in PTH rates among the various techniques were similar, and whether differences seen are clinically significant remains uncertain.

Differences by Indication. Surgical indication is another commonly referenced factor that could influence the frequency of PTH.[149,152,184] Standard teaching is that patients with recurrent throat infections are more likely to have postoperative bleeding. This is thought to relate to the inflammatory process occurring in and around the tonsil, less distinct dissection planes, and associated increased vascularity.[130,152,185-187] Unadjusted analyses confirmed this suspicion. Across techniques and types of tonsillectomy (partial or total), children undergoing tonsillectomy for OSDB had lower rates of PTH than those whose indication was recurrent infection (1.9% vs 3.9%).

Partial vs Total Tonsillectomy. Controversy exists regarding whether bleeding rates differ between total and partial tonsillectomy. Proponents of partial tonsillectomy argue that it is as effective as total tonsillectomy at treating underlying pathology, with less pain and a lower rate of PTH and other complications.[124,188-192] Pooled rates (without adjustment) of PTH were also <5% overall (4.2% for total tonsillectomy, 1.5% for partial tonsillectomy) in comparative studies. In meta-analysis, we compared the frequency of PTH between partial and total tonsillectomy and found that primary and secondary PTH associated with both approaches were <4% for any surgical technique and across all techniques, with overlapping confidence bounds (total tonsillectomy: primary PTH = 0.5% [95% BCI: 0.1%-1%], secondary PTH = 2.9% [95% BCI: 1.5%-4.3%]; partial tonsillectomy: primary PTH = 1.7% [95% BCI: 0%-4.6%], secondary PTH = 0.4% [95% BCI: 0%-1.2%]). Thus, evidence herein does support the supposition that partial tonsillectomy has a lower PTH rate. In terms of approach, potential differences in PTH risk must be considered within the broader risk-benefit ratio, including possible regrowth of tonsils. Note that few studies addressed partial tonsillectomy, which could influence effect size precision.

Though not formally assessed in the current review, other studies have addressed potential risk factors for PTH. Older age and male sex have variably been associated with greater risk of bleeding.[**] Furthermore, we could not assess baseline severity of obstruction (eg, apnea-hypopnea index or polysomnography for OSDB) and infection severity (number or type of infections) as risk factors in our review, given limitations in reporting. Finally, effects of surgeon skill and experience on PTH are not clear, are difficult to measure, and are rarely reported in this literature.[3,4,151,155,193]

Mortality and Tonsillectomy

Several large case series, databases, and clinical registries have been used to evaluate the harms associated with tonsillectomy. These studies are important because comparative studies like those used in meta-analyses often underestimate harms and/or may not capture more rare and serious consequences, such as death.[194,195] Deaths were reported, albeit rarely. Specifically, at least 4 deaths were reported across case series or database studies (low or moderate risk of bias) including 1,778,342 children. This translates into a mortality rate of approximately 1 per 500,000, which is lower than that referenced for pediatric general anesthesia (<1 per 10,000).[196,197] This difference may relate to the general overall health (ie, as classified using the American Society of Anesthesiologists [ASA] physical status) of children undergoing tonsillectomy as compared with the totality of children undergoing surgery with general anesthesia. Studies reporting ASA class in the current review consistently included children with ASA I or II status (ie, healthy patients or those with mild systemic disease and no substantive functional limitations).[198]

[**]References 124, 126, 129, 137, 142, 143, 157

We limited our search to English publications; therefore, applicable studies published in other languages were not captured. Other limitations relate to the state of the current literature. Heterogeneity in reporting was evident across studies, thereby reducing the ability to combine all candidate studies for meta-analyses. Contributing to imprecision of PTH estimates was a lack of consistency or clarity in reporting (1) timing of bleeding; (2) utilization consequences (ie, revisits/readmissions, reoperations); (3) severity of bleeding (generally not explicitly recorded); (4) stringency of methods for capturing instances of PTH, which could have varied from reporting blood-tinged sputum to reporting only frank bleeding; and (5) the modifying effect of severity of indication for tonsillectomy (infection or OSDB [eg, apnea-hypopnea index]). We attempted to overcome the absence of direct data on severity of bleeding by assuming that bleeding was progressively more severe if (1) reported and not requiring revisit or readmission, (2) need for revisit and/or readmission, or (3) reoperation for hemostasis. Heterogeneity also precluded analyses that adjusted for the potential effects of differing anesthesia regimens, perioperative medication use, patient comorbidities, and surgeon-related factors. Nonetheless, the methodology used optimized estimates based on the state of the literature on this topic.

Conclusions

In conclusion, we found relatively low rates of PTH, with higher rates associated with total vs partial tonsillectomy and with similar rates among commonly used techniques (eg, cold dissection, coblation). The frequency of revisits/readmissions or reoperations to control hemostasis was generally <5%. Evidence in this review does not support the superiority of one approach (partial vs total) or any one technique over another. Finally, the clinical significance of PTH is inextricably tied to the severity of such bleeding, which influences both the risk to the patient and the potential need for intervention. The paucity of bleeding severity data also limits a comprehensive comparison of techniques.

Acknowledgments

We thank the entire review team for its contributions to the full report. We are indebted to Jessica Kimber, and Katherine Worley, MLIS, for their assistance with data extraction. We also sincerely thank our Agency for Healthcare Research and Quality task order officers and associate editor for their input throughout the review process.

Author Contributions

David O. Francis, helped to conceptualize and design the review, drafted and revised the initial manuscript, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work; **Christopher Fonnesbeck**, helped to conceptualize and design the review, developed and conducted the meta-analysis, helped to revise the initial manuscript, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work; **Nila Sathe**, helped to conceptualize and design the review, helped to draft and revise the initial manuscript, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work; **Melissa McPheeters**, helped to conceptualize and design the review, helped to draft and revise the initial manuscript, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work; **Shanthi Krishnaswami**, helped to conceptualize and design the review, helped to extract and analyze data and revise the initial manuscript, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work; **Sivakumar Chinnadurai**, helped to conceptualize and design the review, helped to revise the initial manuscript, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work.

Disclosures

Competing interests: None.

Sponsorships: None.

Funding source: Agency for Healthcare Research and Quality; National Institute on Deafness and Other Communication Disorders of the National Institutes of Health All authors received funding for this project under contract HHSA290201500003I from the Agency for Healthcare Research and Quality, US Department of Health and Human Services. Salary support for David O. Francis came from grants K23DC013559 and L30DC012687 from the National Institute on Deafness and Other Communication Disorders of the National Institutes of Health. No authors have any other financial or other disclosures relevant to this article. Funding agencies did not participate in the conduct of the review. The Agency for Healthcare Research and Quality provided input on the draft report but was not responsible for the conduct of the review.

References

1. Cullen KA, Hall MJ, Golosinskiy A. Ambulatory surgery in the United States, 2006. *Natl Health Stat Report*. 2009;11:1-25.
2. Mitchell RM, Parikh SR. Hemostasis in tonsillectomy. *Otolaryngol Clin North Am*. 2016;49:615-626.
3. Sarny S, Ossimitz G, Habermann W, et al. Hemorrhage following tonsil surgery: a multicenter prospective study. *Laryngoscope*. 2011;121:2553-2560.
4. Sarny S, Habermann W, Ossimitz G, et al. What lessons can be learned from the Austrian events? *ORL J Otorhinolaryngol Relat Spec*. 2013;75:175-181.
5. Viswanathan M, Ansari MT, Berkman ND, et al. Assessing the risk of bias of individual studies in systematic reviews of health care interventions. In: *Methods Guide for Effectiveness and Comparative Effectiveness Reviews*. Rockville, MD: Agency for Healthcare Research and Quality; 2008.
6. Berkman ND, Lohr KN, Ansari MT, et al. Grading the strength of a body of evidence when assessing health care interventions: an EPC update. *J Clin Epidemiol*. 2015;68:1312-1324.
7. Francis DO, Chinnadurai S, Sathe NA, et al. *Tonsillectomy for Obstructive Sleep-Disordered Breathing or Recurrent Throat Infection in Children*. Rockville, MD: Agency for Healthcare Research and Quality; in press.
8. Marcus CL, Moore RH, Rosen CL, et al. A randomized trial of adenotonsillectomy for childhood sleep apnea. *N Engl J Med*. 2013;368:2366-2376.
9. Weinstock TG, Rosen CL, Marcus CL, et al. Predictors of obstructive sleep apnea severity in adenotonsillectomy candidates. *Sleep*. 2014;37:261-269.

10. Katz ES, Moore RH, Rosen CL, et al. Growth after adenotonsillectomy for obstructive sleep apnea: an RCT. *Pediatrics*. 2014;134:282-289.
11. Quante M, Wang R, Weng J, et al. The effect of adenotonsillectomy for childhood sleep apnea on cardiometabolic measures. *Sleep*. 2015;38:1395-1403.
12. Garetz SL, Mitchell RB, Parker PD, et al. Quality of life and obstructive sleep apnea symptoms after pediatric adenotonsillectomy. *Pediatrics*. 2015;135:e477-e486.
13. Rosen CL, Wang R, Taylor HG, et al. Utility of symptoms to predict treatment outcomes in obstructive sleep apnea syndrome. *Pediatrics*. 2015;135:e662-e671.
14. Chervin RD, Ellenberg SS, Hou X, et al. Prognosis for spontaneous resolution of obstructive sleep apnea in children. *Chest*. 2015;148:1204-1213.
15. Konstantinopoulou S, Gallagher P, Elden L, et al. Complications of adenotonsillectomy for obstructive sleep apnea in school-aged children. *Int J Pediatr Otorhinolaryngol*. 2015;79:240-245.
16. Murto K, Lamontagne C, McFaul C, et al. Celecoxib pharmacogenetics and pediatric adenotonsillectomy: a double-blinded randomized controlled study. *Can J Anaesth*. 2015;62:785-797.
17. Abdel-Ghaffar HS, Abdel-Azeem HG, Roushdy MM. Safety and efficacy of pre-incisional peritonsillar lornoxicam in paediatric post-tonsillectomy pain: a prospective double-blind, placebo-controlled, split-body clinical study. *Clin Otolaryngol*. 2015;40:219-226.
18. Park SK, Kim J, Kim JM, et al. Effects of oral prednisolone on recovery after tonsillectomy. *Laryngoscope*. 2015;125:111-117.
19. D'Eredita R. Molecular resonance tonsillectomy in children: comparative study over standard techniques in an 11-year study. *Otolaryngol Head Neck Surg*. 2014;151:861-867.
20. Sudarsan SS, Paramasivan VK, Arumugam SV, et al. Comparison of treatment modalities in syndromic children with obstructive sleep apnea—a randomized cohort study. *Int J Pediatr Otorhinolaryngol*. 2014;78:1526-1533.
21. Aysenur D, Mine C, Ozgur Y, et al. Pre-emptive peritonsillar dexamethasone vs levobupivacaine infiltration for relief of post-adenotonsillectomy pain in children: a controlled clinical study. *Int J Pediatr Otorhinolaryngol*. 2014;78:1467-1471.
22. Moss JR, Watcha MF, Bendel LP, et al. A multicenter, randomized, double-blind placebo-controlled, single dose trial of the safety and efficacy of intravenous ibuprofen for treatment of pain in pediatric patients undergoing tonsillectomy. *Paediatr Anaesth*. 2014;24:483-489.
23. Aydin S, Taskin U, Altas B, et al. Post-tonsillectomy morbidities: randomised, prospective controlled clinical trial of cold dissection versus thermal welding tonsillectomy. *J Laryngol Otol*. 2014;128:163-165.
24. Moriniere S, Roux A, Bakhos D, et al. Radiofrequency tonsillotomy versus bipolar scissors tonsillectomy for the treatment of OSAS in children: a prospective study. *Eur Ann Otorhinolaryngol Head Neck Dis*. 2013;130:67-72.
25. Chaidas KS, Kaditis AG, Papadakis CE, et al. Tonsilloplasty versus tonsillectomy in children with sleep-disordered breathing: short- and long-term outcomes. *Laryngoscope*. 2013;123:1294-1299.
26. Gallagher TQ, Hill C, Ojha S, et al. Perioperative dexamethasone administration and risk of bleeding following tonsillectomy in children: a randomized controlled trial. *JAMA*. 2012;308:1221-1226.
27. Frampton SJ, Ward MJ, Sunkaraneni VS, et al. Guillotine versus dissection tonsillectomy: randomised, controlled trial. *J Laryngol Otol*. 2012;126:1142-1149.
28. Hermans V, De Pooter F, De Groote F, et al. Effect of dexamethasone on nausea, vomiting, and pain in paediatric tonsillectomy. *Br J Anaesth*. 2012;109:427-431.
29. Havel M, Sroka R, Englert E, et al. Intraindividual comparison of 1,470 nm diode laser versus carbon dioxide laser for tonsillotomy: a prospective, randomized, double blind, controlled feasibility trial. *Lasers Surg Med*. 2012;44:558-563.
30. Aouad MT, Nasr VG, Yazbeck-Karam VG, et al. A comparison between dexamethasone and methylprednisolone for vomiting prophylaxis after tonsillectomy in inpatient children: a randomized trial. *Anesth Analg*. 2012;115:913-920.
31. Ozkiris M, Kapusuz Z, Yildirim YS, et al. The effect of paracetamol, metamizole sodium and ibuprofen on postoperative hemorrhage following pediatric tonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2012;76:1027-1029.
32. Macassey E, Dawes P, Taylor B, et al. The effect of a postoperative course of oral prednisone on postoperative morbidity following childhood tonsillectomy. *Otolaryngol Head Neck Surg*. 2012;147:551-556.
33. Paramasivan VK, Arumugam SV, Kameswaran M. Randomised comparative study of adenotonsillectomy by conventional and coblation method for children with obstructive sleep apnoea. *Int J Pediatr Otorhinolaryngol*. 2012;76:816-821.
34. Chang H, Hah JH. Comparison of post-tonsillectomy pain with two different types of bipolar forceps: low temperature quantum molecular resonance device versus high temperature conventional electrocautery. *Acta Otolaryngol*. 2012;132(suppl 1):S130-S133.
35. Ozkiris M. Comparison of three techniques in pediatric tonsillectomy. *Eur Arch Otorhinolaryngol*. 2012;269:1497-1501.
36. Parker NP, Walner DL. Post-operative pain following coblation or monopolar electrocautery tonsillectomy in children: a prospective, single-blinded, randomised comparison. *Clin Otolaryngol*. 2011;36:468-474.
37. Ragab MA, Atef A, Mosleh M, et al. Bipolar scissors tonsillectomy: what are the advantages? *J Otolaryngol Head Neck Surg*. 2011;40:256-260.
38. D'Eredita R. Tonsillectomy in children: a five-factor analysis among three techniques—reporting upon clinical results, anesthesia time, surgery time, bleeding, and cost. *Laryngoscope*. 2010;120:2502-2507.
39. Pruegsanusak K, Wongsuwan K, Wongkittithawon J. A randomized controlled trial for perioperative morbidity in microdebrider versus cold instrument dissection tonsillectomy. *J Med Assoc Thai*. 2010;93:558-565.
40. D'Eredita R, Bozzola L. Molecular resonance vs coblation tonsillectomy in children. *Laryngoscope*. 2009;119:1897-1901.
41. Parker D, Howe L, Unsworth V, et al. A randomised controlled trial to compare postoperative pain in children undergoing

tonsillectomy using cold steel dissection with bipolar haemostasis versus coblation technique. *Clin Otolaryngol*. 2009;34:225-231.
42. Czarnetzki C, Elia N, Lysakowski C, et al. Dexamethasone and risk of nausea and vomiting and postoperative bleeding after tonsillectomy in children: a randomized trial. *JAMA*. 2008;300:2621-2630.
43. Hesham A. Bipolar diathermy versus cold dissection in paediatric tonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2009;73:793-795.
44. Sezen OS, Kaytanci H, Kubilay U, et al. Comparison between tonsillectomy with thermal welding and the conventional "cold" tonsillectomy technique. *ANZ J Surg*. 2008;78:1014-1018.
45. Di Rienzo Businco L, Coen Tirelli G. Paediatric tonsillectomy: radiofrequency-based plasma dissection compared to cold dissection with sutures. *Acta Otorhinolaryngol Ital*. 2008;28:67-72.
46. Chimona T, Proimos E, Mamoulakis C, et al. Multiparametric comparison of cold knife tonsillectomy, radiofrequency excision and thermal welding tonsillectomy in children. *Int J Pediatr Otorhinolaryngol*. 2008;72:1431-1436.
47. Korkmaz O, Bektas D, Cobanoglu B, et al. Partial tonsillectomy with scalpel in children with obstructive tonsillar hypertrophy. *Int J Pediatr Otorhinolaryngol*. 2008;72:1007-1012.
48. Vlastos IM, Parpounas K, Economides J, et al. Tonsillectomy versus tonsillotomy performed with scissors in children with tonsillar hypertrophy. *Int J Pediatr Otorhinolaryngol*. 2008;72:857-863.
49. Chang KW. Intracapsular versus subcapsular coblation tonsillectomy. *Otolaryngol Head Neck Surg*. 2008;138:153-157.
50. Skoulakis CE, Papadakis CE, Manios AG, et al. Tonsilloplasty in children with obstructive symptoms. *J Otolaryngol*. 2007;36:240-246.
51. Bukhari MA, Al-Ammar AY. Monopolar electrodissection versus cold dissection tonsillectomy among children. *Saudi Med J*. 2007;28:1525-1528.
52. Mitic S, Tvinnereim M, Lie E, et al. A pilot randomized controlled trial of coblation tonsillectomy versus dissection tonsillectomy with bipolar diathermy haemostasis. *Clin Otolaryngol*. 2007;32:261-267.
53. Park A, Proctor MD, Alder S, et al. Subtotal bipolar tonsillectomy does not decrease postoperative pain compared to total monopolar tonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2007;71:1205-1210.
54. Hegazy HM, Albirmawy OA, Kaka AH, et al. Pilot comparison between potassium titanyl phosphate laser and bipolar radiofrequency in paediatric tonsillectomy. *J Laryngol Otol*. 2008;122:369-373.
55. Shapiro NL, Bhattacharyya N. Cold dissection versus coblation-assisted adenotonsillectomy in children. *Laryngoscope*. 2007;117:406-410.
56. Coticchia JM, Yun RD, Nelson L, et al. Temperature-controlled radiofrequency treatment of tonsillar hypertrophy for reduction of upper airway obstruction in pediatric patients. *Arch Otolaryngol Head Neck Surg*. 2006;132:425-430.
57. Leaper M, Mahadevan M, Vokes D, et al. A prospective randomised single blinded study comparing harmonic scalpel tonsillectomy with bipolar tonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2006;70:1389-1396.
58. Derkay CS, Darrow DH, Welch C, et al. Post-tonsillectomy morbidity and quality of life in pediatric patients with obstructive tonsils and adenoid: microdebrider vs electrocautery. *Otolaryngol Head Neck Surg*. 2006;134:114-120.
59. Oko MO, Ganly I, Loughran S, et al. 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.
60. Kaan MN, Odabasi O, Gezer E, et al. The effect of preoperative dexamethasone on early oral intake, vomiting and pain after tonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2006;70:73-79.
61. Kedek A, Derbent A, Uyar M, et al. Pre-emptive effects of ibuprofen syrup and lidocaine infiltration on post-operative analgesia in children undergoing adenotonsillectomy. *J Int Med Res*. 2005;33:188-195.
62. Collison PJ, Weiner R. Harmonic scalpel versus conventional tonsillectomy: a double-blind clinical trial. *Ear Nose Throat J*. 2004;83:707-710.
63. Chan KH, Friedman NR, Allen GC, et al. Randomized, controlled, multisite study of intracapsular tonsillectomy using low-temperature plasma excision. *Arch Otolaryngol Head Neck Surg*. 2004;130:1303-1307.
64. D'Eredita R, Marsh RR. Contact diode laser tonsillectomy in children. *Otolaryngol Head Neck Surg*. 2004;131:732-735.
65. Hanasono MM, Lalakea ML, Mikulec AA, et al. Perioperative steroids in tonsillectomy using electrocautery and sharp dissection techniques. *Arch Otolaryngol Head Neck Surg*. 2004;130:917-921.
66. Lalicevic S, Djordjevic I. Comparison of benzydamine hydrochloride and *Salvia officinalis* as an adjuvant local treatment to systemic nonsteroidal anti-inflammatory drug in controlling pain after tonsillectomy, adenoidectomy, or both: an open-label, single-blind, randomized clinical trial. *Curr Ther Res Clin Exp*. 2004;65:360-372.
67. Stoker KE, Don DM, Kang DR, et al. Pediatric total tonsillectomy using coblation compared to conventional electrosurgery: a prospective, controlled single-blind study. *Otolaryngol Head Neck Surg*. 2004;130:666-675.
68. Keidan I, Zaslansky R, Eviatar E, et al. Intraoperative ketorolac is an effective substitute for fentanyl in children undergoing outpatient adenotonsillectomy. *Paediatr Anaesth*. 2004;14:318-323.
69. Elhakim M, Ali NM, Rashed I, et al. Dexamethasone reduces postoperative vomiting and pain after pediatric tonsillectomy. *Can J Anaesth*. 2003;50:392-397.
70. Silveira H, Soares JS, Lima HA. Tonsillectomy: cold dissection versus bipolar electrodissection. *Int J Pediatr Otorhinolaryngol*. 2003;67:345-351.
71. Willging JP, Wiatrak BJ. Harmonic scalpel tonsillectomy in children: a randomized prospective study. *Otolaryngol Head Neck Surg*. 2003;128:318-325.
72. Kothari P, Patel S, Brown P, et al. A prospective double-blind randomized controlled trial comparing the suitability of KTP laser tonsillectomy with conventional dissection tonsillectomy for day case surgery. *Clin Otolaryngol Allied Sci*. 2002;27:369-373.
73. Paradise JL, Bluestone CD, Colborn DK, et al. Tonsillectomy and adenotonsillectomy for recurrent throat infection in moderately affected children. *Pediatrics*. 2002;110:7-15.

74. Shah UK, Galinkin J, Chiavacci R, et al. Tonsillectomy by means of plasma-mediated ablation: prospective, randomized, blinded comparison with monopolar electrosurgery. *Arch Otolaryngol Head Neck Surg*. 2002;128:672-676.
75. Raut VV, Bhat N, Sinnathuray AR, et al. Bipolar scissors versus cold dissection for pediatric tonsillectomy—a prospective, randomized pilot study. *Int J Pediatr Otorhinolaryngol*. 2002;64:9-15.
76. Young C, MacRae J. Tonsillectomy: a comparative study of dissection/snare vs suction-cautery. *Can Oper Room Nurs J*. 2001;19:7-11.
77. Walker RA, Syed ZA. Harmonic scalpel tonsillectomy versus electrocautery tonsillectomy: a comparative pilot study. *Otolaryngol Head Neck Surg*. 2001;125:449-455.
78. Temple RH, Timms MS. Paediatric coblation tonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2001;61:195-198.
79. 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.
80. Stage J, Jensen JH, Bonding P. Post-tonsillectomy haemorrhage and analgesics: a comparative study of acetylsalicylic acid and paracetamol. *Clin Otolaryngol Allied Sci*. 1988;13:201-204.
81. Beriat GK, Ezerarslan H, Kocaturk S. Microdebrider tonsillotomy in children with obstructive tonsillar hypertrophy. *J Clin Anal Med*. 2013;4(6):462-465.
82. Al-Shehri AMS. Post-tonsillectomy pain and bleeding in children: a comparison of traditional tonsillectomy with electrodissection tonsillectomy. *Current Pediatric Research*. 2012;16:150-152.
83. Omrani M, Barati B, Omidifar N, et al. Coblation versus traditional tonsillectomy: a double blind randomized controlled trial. *J Res Med Sci*. 2012;17:45-50.
84. Haraldsson PO, Attner P, Fredelius L, et al. Intrapersonal randomized controlled trial comparing bipolar scissors and conventional cold tonsillectomy. *Otorhinolaryngology Clinics*. 2011;3:79-83.
85. Alajmi MA, Al Noumas HS, Al-Abdulhadi KA, et al. Steroids for reducing post-tonsillectomy morbidity. *Kuwait Medical Journal*. 2008;40:211-215.
86. Nawasreh O, Fraihat A, Maaita J. The effect of preoperative intravenous dexamethasone in pediatric adenotonsillectomy. *J Bahrain Med Soc*. 2000;12:130-133.
87. Lee IH, Sung CY, Han JI, et al. The preemptive analgesic effect of ketorolac and propacetamol for adenotonsillectomy in pediatric patients. *Korean J Anesthesiol*. 2009;57:308-313.
88. Lister M. Microdebrider partial tonsillectomy vs electrosurgical tonsillectomy: a randomized, double-blind, paired-control study of postoperative pain. Paper presented at: 20th Annual Meeting of the American Society of Pediatric Otolaryngology; May 28, 2005; Las Vegas, NV.
89. Salama MA. Harmonic scalpel tonsillectomy versus coblation tonsillectomy. *Menoufiya Medical Journal*. 2012;25(2):53-60.
90. Matin M, Chowdhury MA, Haque ME, et al. Coblation tonsillectomy versus blunt dissectomy tonsillectomy in children. *Anwer Khan Modern Medical College Journal*. 2013;4:25-29.
91. Gabr S, Harhash K, Fouly M, et al. Microdebrider intracapsular tonsillotomy versus conventional extracapsular tonsillectomy. *The Egyptian Journal of Otolaryngology*. 2014;30:220.
92. Salomone R, Visioli AJ, Aquino MM, Takahashi EN, Matsuyama C. Ultrasonic curved shears in tonsillectomy: comparative clinical trial between this new surgical technique and the technique with the cold blade surgical knife. *Intl Arch Otorhinolaryngol*. 2007;11:444-452.
93. Solanki NS, Goswami M, Thaker N. Bupivacaine infiltration versus diclofenac suppository for post-tonsillectomy pain relief in paediatric patients. *National Journal of Medical Research*. 2012;2:5-7.
94. Chettri S, Bhandary S, Nepal A, et al. A single blind controlled study comparing bipolar elecrocautery tonsillectomy to cold dissection method in pediatric age groups. *Health Renaissance*. 2014;11:270-272.
95. Elbadawey MR, Hegazy HM, Eltahan AE, et al. A randomised controlled trial of coblation, diode laser and cold dissection in paediatric tonsillectomy. *J Laryngol Otol*. 2015;129(11):1058-1063.
96. van Staaij BK, van den Akker EH, Rovers MM, et al. Effectiveness of adenotonsillectomy in children with mild symptoms of throat infections or adenotonsillar hypertrophy: open, randomised controlled trial. *BMJ*. 2004;329:651.
97. Buskens E, van Staaij B, van den Akker J, et al. Adenotonsillectomy or watchful waiting in patients with mild to moderate symptoms of throat infections or adenotonsillar hypertrophy: a randomized comparison of costs and effects. *Arch Otolaryngol Head Neck Surg*. 2007;133:1083-1088.
98. Le TM, Rovers MM, van Staaij BK, et al. Alterations of the oropharyngeal microbial flora after adenotonsillectomy in children: a randomized controlled trial. *Arch Otolaryngol Head Neck Surg*. 2007;133:969-972.
99. Stelter K, de la Chaux R, Patscheider M, et al. Double-blind, randomised, controlled study of post-operative pain in children undergoing radiofrequency tonsillotomy versus laser tonsillotomy. *J Laryngol Otol*. 2010;124:880-885.
100. Stelter K, Ihrler S, Siedek V, et al. 1-year follow-up after radiofrequency tonsillotomy and laser tonsillotomy in children: a prospective, double-blind, clinical study. *Eur Arch Otorhinolaryngol*. 2012;269:679-684.
101. Roje Z, Racic G, Dogas Z, et al. Postoperative morbidity and histopathologic characteristics of tonsillar tissue following coblation tonsillectomy in children: a prospective randomized single-blind study. *Coll Antropol*. 2009;33:293-298.
102. Roje Z, Racic G, Kardum G, et al. Is the systemic inflammatory reaction to surgery responsible for post-operative pain after tonsillectomy, and is it "technique-related"? *Wien Klin Wochenschr*. 2011;123:479-484.
103. Ericsson E, Graf J, Hultcrantz E. Pediatric tonsillotomy with radiofrequency technique: long-term follow-up. *Laryngoscope*. 2006;116:1851-1857.
104. Ericsson E, Wadsby M, Hultcrantz E. Pre-surgical child behavior ratings and pain management after two different techniques of tonsil surgery. *Int J Pediatr Otorhinolaryngol*. 2006;70:1749-1758.
105. Hultcrantz E, Ericsson E. Pediatric tonsillotomy with the radiofrequency technique: less morbidity and pain. *Laryngoscope*. 2004;114:871-877.
106. Ericsson E, Graf J, Lundeborg-Hammarstrom I, et al. Tonsillotomy versus tonsillectomy on young children: 2 year post surgery follow-up. *J Otolaryngol Head Neck Surg*. 2014;43:26.

107. Ericsson E, Lundeborg I, Hultcrantz E. Child behavior and quality of life before and after tonsillotomy versus tonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2009;73:1254-1262.
108. Lorusso F, Gallina S, Modica DM, et al. Bipolar quantum molecular resonance versus blunt dissection tonsillectomy. *B-ENT*. 2015;11:101-108.
109. Yilmaz M, Duzlu M, Catli T, et al. Thermal welding versus cold knife tonsillectomy: a prospective randomized study. *Kaohsiung J Med Sci*. 2012;28:270-272.
110. Kemal O. Harmonic scalpel versus bipolar tonsillectomy: a double-blind clinical trial. *Eur Arch Otorhinolaryngol*. 2012;269:1533-1536.
111. Wilson YL, Merer DM, Moscatello AL. Comparison of three common tonsillectomy techniques: a prospective randomized, double-blinded clinical study. *Laryngoscope*. 2009;119:162-170.
112. Lee SW, Jeon SS, Lee JD, et al. A comparison of postoperative pain and complications in tonsillectomy using BiClamp forceps and electrocautery tonsillectomy. *Otolaryngol Head Neck Surg*. 2008;139:228-234.
113. D'Agostino R, Tarantino V, Calevo MG. Blunt dissection versus electronic molecular resonance bipolar dissection for tonsillectomy: operative time and intraoperative and postoperative bleeding and pain. *Int J Pediatr Otorhinolaryngol*. 2008;72:1077-1084.
114. Sobol SE, Wetmore RF, Marsh RR, et al. Postoperative recovery after microdebrider intracapsular or monopolar electrocautery tonsillectomy: a prospective, randomized, single-blinded study. *Arch Otolaryngol Head Neck Surg*. 2006;132:270-274.
115. 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.
116. Ragab SM. Bipolar radiofrequency dissection tonsillectomy: a prospective randomized trial. *Otolaryngol Head Neck Surg*. 2005;133:961-965.
117. Kamal SA, Basu S, Kapoor L, et al. Harmonic scalpel tonsillectomy: a prospective study. *Eur Arch Otorhinolaryngol*. 2006;263:449-454.
118. Kirazli T, Bilgen C, Midilli R, et al. Bipolar electrodissection tonsillectomy in children. *Eur Arch Otorhinolaryngol*. 2005;262:716-718.
119. Densert O, Desai H, Eliasson A, et al. Tonsillotomy in children with tonsillar hypertrophy. *Acta Otolaryngol*. 2001;121:854-858.
120. Beriat GK, Ezerarslan H, Ekmekci P, et al. The use of bipolar electrocautery tonsillectomy in patients with pediatric respiratory tract obstruction. *Journal of Clinical and Analytical Medicine*. 2012;3:36-40.
121. Bitar MA, Rameh C. Microdebrider-assisted partial tonsillectomy: short- and long-term outcomes. *Eur Arch Otorhinolaryngol*. 2008;265:459-463.
122. Kordeluk S, Goldbart A, Novack L, et al. Randomized study comparing inflammatory response after tonsillectomy versus tonsillotomy. *Eur Arch Otorhinolaryngol*. 2016;273:3993-4001.
123. Edmonson MB, Eickhoff JC, Zhang C. A population-based study of acute care revisits following tonsillectomy. *J Pediatr*. 2015;166:607-612, e5.
124. Hessen Soderman AC, Ericsson E, Hemlin C, et al. Reduced risk of primary postoperative hemorrhage after tonsil surgery in Sweden: results from the National Tonsil Surgery Register in Sweden covering more than 10 years and 54,696 operations. *Laryngoscope*. 2011;121:2322-2326.
125. Kvaerner KJ. Benchmarking surgery: secondary post-tonsillectomy hemorrhage 1999-2005. *Acta Otolaryngol*. 2009;129:195-198.
126. Tomkinson A, De Martin S, Gilchrist CR, et al. Instrumentation and patient characteristics that influence postoperative haemorrhage rates following tonsil and adenoid surgery. *Clin Otolaryngol*. 2005;30:338-346.
127. Clark MP, Waddell A. The surgical arrest of post-tonsillectomy haemorrhage: hospital episode statistics. *Ann R Coll Surg Engl*. 2004;86:411-412.
128. Lavin JM, Shah RK. Postoperative complications in obese children undergoing adenotonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2015;79:1732-1735.
129. Duval M, Wilkes J, Korgenski K, et al. Causes, costs, and risk factors for unplanned return visits after adenotonsillectomy in children. *Int J Pediatr Otorhinolaryngol*. 2015;79:1640-1646.
130. Spektor Z, Saint-Victor S, Kay DJ, et al. Risk factors for pediatric post-tonsillectomy hemorrhage. *Int J Pediatr Otorhinolaryngol*. 2016;84:151-155.
131. Kshirsagar R, Mahboubi H, Moriyama D, et al. Increased immediate postoperative hemorrhage in older and obese children after outpatient tonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2016;84:119-123.
132. Harounian JA, Schaefer E, Schubart J, et al. Pediatric posttonsillectomy hemorrhage: demographic and geographic variation in health care costs in the United States. *Otolaryngol Head Neck Surg*. 2016;155:289-294.
133. Odhagen E, Sunnergren O, Hemlin C, et al. Risk of reoperation after tonsillotomy versus tonsillectomy: a population-based cohort study. *Eur Arch Otorhinolaryngol*. 2016;273:3263-3268.
134. Raol N, Zogg CK, Boss EF, et al. Inpatient pediatric tonsillectomy: does hospital type affect cost and outcomes of care? *Otolaryngol Head Neck Surg*. 2016;154:486-493.
135. Pfaff JA, Hsu K, Chennupati SK. The use of ibuprofen in post-tonsillectomy analgesia and its effect on posttonsillectomy hemorrhage rate. *Otolaryngol Head Neck Surg*. 2016;155:508-513.
136. Tomkinson A, Harrison W, Owens D, et al. Postoperative hemorrhage following adenoidectomy. *Laryngoscope*. 2012;122:1246-1253.
137. Tomkinson A, Harrison W, Owens D, et al. Risk factors for postoperative hemorrhage following tonsillectomy. *Laryngoscope*. 2011;121:279-288.
138. Lowe D, van der Meulen J, Cromwell D, et al. Key messages from the National Prospective Tonsillectomy Audit. *Laryngoscope*. 2007;117:717-724.
139. Lowe D, Cromwell DA, Lewsey JD, et al. Diathermy power settings as a risk factor for hemorrhage after tonsillectomy. *Otolaryngol Head Neck Surg*. 2009;140:23-28.
140. Lowe D, van der Meulen J. Tonsillectomy technique as a risk factor for postoperative haemorrhage. *Lancet*. 2004;364:697-702.

141. Shay S, Shapiro NL, Bhattacharyya N. Revisit rates and diagnoses following pediatric tonsillectomy in a large multistate population. *Laryngoscope*. 2015;125:457-461.
142. Bhattacharyya N, Shapiro NL. Associations between socioeconomic status and race with complications after tonsillectomy in children. *Otolaryngol Head Neck Surg*. 2014;151:1055-1060.
143. Mahant S, Keren R, Localio R, et al. Variation in quality of tonsillectomy perioperative care and revisit rates in children's hospitals. *Pediatrics*. 2014;133:280-288.
144. Mahant S, Keren R, Localio R, et al. Dexamethasone and risk of bleeding in children undergoing tonsillectomy. *Otolaryngol Head Neck Surg*. 2014;150:872-879.
145. Hultcrantz E, Ericsson E, Hemlin C, et al. Paradigm shift in Sweden from tonsillectomy to tonsillotomy for children with upper airway obstructive symptoms due to tonsillar hypertrophy. *Eur Arch Otorhinolaryngol*. 2013;270:2531-2536.
146. Sunnergren O, Hemlin C, Ericsson E, et al. Radiofrequency tonsillotomy in Sweden 2009-2012. *Eur Arch Otorhinolaryngol*. 2014;271:1823-1827.
147. Elinder K, Soderman AH, Stalfors J, et al. Factors influencing morbidity after paediatric tonsillectomy: a study of 18,712 patients in the National Tonsil Surgery Register in Sweden. *Eur Arch Otorhinolaryngol*. 2016;273:2249-2256.
148. Padia R, Olsen G, Henrichsen J, et al. Hospital and surgeon adherence to pediatric tonsillectomy guidelines regarding perioperative dexamethasone and antibiotic administration. *Otolaryngol Head Neck Surg*. 2015;153:275-280.
149. Achar P, Sharma RK, De S, et al. Does primary indication for tonsillectomy influence post-tonsillectomy haemorrhage rates in children? *Int J Pediatr Otorhinolaryngol*. 2015;79:246-250.
150. Suzuki S, Yasunaga H, Matsui H, et al. Impact of systemic steroids on posttonsillectomy bleeding: analysis of 61 430 patients using a national inpatient database in Japan. *JAMA Otolaryngol Head Neck Surg*. 2014;140:906-910.
151. Walner DL, Miller SP, Villines D, et al. Coblation tonsillectomy in children: incidence of bleeding. *Laryngoscope*. 2012;122:2330-2336.
152. Perkins JN, Liang C, Gao D, et al. Risk of post-tonsillectomy hemorrhage by clinical diagnosis. *Laryngoscope*. 2012;122: 2311-2315.
153. Tweedie DJ, Bajaj Y, Ifeacho SN, et al. Peri-operative complications after adenotonsillectomy in a UK pediatric tertiary referral centre. *Int J Pediatr Otorhinolaryngol*. 2012;76:809-815.
154. Bhattacharyya N. Ambulatory pediatric otolaryngologic procedures in the United States: characteristics and perioperative safety. *Laryngoscope*. 2010;120:821-825.
155. Kim DW, Koo JW, Ahn SH, et al. Difference of delayed post-tonsillectomy bleeding between children and adults. *Auris Nasus Larynx*. 2010;37:456-460.
156. D'Agostino R, Tarantino V, Calevo MG. Post-tonsillectomy late haemorrhage: is it a preferably night-time event? *Int J Pediatr Otorhinolaryngol*. 2009;73:713-716.
157. Arnoldner C, Grasl M, Thurnher D, et al. Surgical revision of hemorrhage in 8388 patients after cold-steel adenotonsillectomies. *Wien Klin Wochenschr*. 2008;120:336-342.
158. Jones DT, Yoon MJ, Licameli G. Effectiveness of postoperative follow-up telephone interviews for patients who underwent adenotonsillectomy: a retrospective study. *Arch Otolaryngol Head Neck Surg*. 2007;133:1091-1095.
159. Mills N, Anderson BJ, Barber C, et al. Day stay pediatric tonsillectomy—a safe procedure. *Int J Pediatr Otorhinolaryngol*. 2004;68:1367-1373.
160. Granell J, Gete P, Villafruela M, et al. Safety of outpatient tonsillectomy in children: a review of 6 years in a tertiary hospital experience. *Otolaryngol Head Neck Surg*. 2004;131:383-387.
161. Liu JH, Anderson KE, Willging JP, et al. Posttonsillectomy hemorrhage: what is it and what should be recorded? *Arch Otolaryngol Head Neck Surg*. 2001;127:1271-1275.
162. Kang J, Brodsky L, Danziger I, et al. Coagulation profile as a predictor for post-tonsillectomy and adenoidectomy (T + A) hemorrhage. *Int J Pediatr Otorhinolaryngol*. 1994;28:157-165.
163. Lannigan FJ, Martin-Hirsch DP, Basey E. Clinical audit: is day-case adenotonsillectomy safe? *Br J Clin Pract*. 1993;47:254-255.
164. Yardley MP. Tonsillectomy, adenoidectomy and adenotonsillectomy: are they safe day case procedures? *J Laryngol Otol*. 1992;106:299-300.
165. Colclasure JB, Graham SS. Complications of outpatient tonsillectomy and adenoidectomy: a review of 3,340 cases. *Ear Nose Throat J*. 1990;69:155-160.
166. Chowdhury K, Tewfik TL, Schloss MD. Post-tonsillectomy and adenoidectomy hemorrhage. *J Otolaryngol*. 1988;17:46-49.
167. Carithers JS, Gebhart DE, Williams JA. Postoperative risks of pediatric tonsilloadenoidectomy. *Laryngoscope*. 1987;97:422-429.
168. Crysdale WS, Russel D. Complications of tonsillectomy and adenoidectomy in 9409 children observed overnight. *CMAJ*. 1986;135:1139-1142.
169. Herdman RC, Bates GJ. Childhood tonsillectomy and discharge after 24 hours. *J Laryngol Otol*. 1986;100:1053-1054.
170. Carmody D, Vamadevan T, Cooper SM. Post tonsillectomy haemorrhage. *J Laryngol Otol*. 1982;96:635-638.
171. Gooda MR, Sheik I, Suleri A. Reducing post operative bleeding after tonsillectomies in children by modifying the monopolar diathermy technique: a study of 1500 patients. *Pak J Med Sci*. 2010;26:434-437.
172. Mahadevan M, van der Meer G, Gruber M, et al. The starship children's hospital tonsillectomy: a further 10 years of experience [published online April 27, 2016]. *Laryngoscope*.
173. Peeters A, Van Rompaey D, Schmelzer B, et al. Tonsillectomy and adenotomy as a one day procedure? *Acta Otorhinolaryngol Belg*. 1999;53:91-97.
174. Windfuhr JP, Chen YS. Incidence of post-tonsillectomy hemorrhage in children and adults: a study of 4,848 patients. *Ear Nose Throat J*. 2002;81:626-628, 630, 632.
175. Windfuhr JP, Chen YS. Hemorrhage following pediatric tonsillectomy before puberty. *Int J Pediatr Otorhinolaryngol*. 2001;58:197-204.
176. Windfuhr JP, Chen YS. Post-tonsillectomy and -adenoidectomy hemorrhage in nonselected patients. *Ann Otol Rhinol Laryngol*. 2003;112:63-70.
177. Orvidas LJ, St Sauver JL, Weaver AL. Efficacy of tonsillectomy in treatment of recurrent group A beta-hemolytic streptococcal pharyngitis. *Laryngoscope*. 2006;116:1946-1950.

178. Chazan B, Shaabi M, Bishara E, et al. Clinical predictors of streptococcal pharyngitis in adults. *Isr Med Assoc J*. 2003;5:413-415.
179. Windfuhr JP, Schloendorff G, Baburi D, et al. Serious posttonsillectomy hemorrhage with and without lethal outcome in children and adolescents. *Int J Pediatr Otorhinolaryngol*. 2008;72:1029-1040.
180. Windfuhr JP, Schloendorff G, Baburi D, et al. Life-threatening posttonsillectomy hemorrhage. *Laryngoscope*. 2008;118:1389-1394.
181. Attner P, Haraldsson PO, Hemlin C, et al. A 4-year consecutive study of post-tonsillectomy haemorrhage. *ORL J Otorhinolaryngol Relat Spec*. 2009;71:273-278.
182. Setabutr D, Adil EA, Adil TK, et al. Emerging trends in tonsillectomy. *Otolaryngol Head Neck Surg*. 2011;145:223-229.
183. Krishna P, LaPage MJ, Hughes LF, et al. Current practice patterns in tonsillectomy and perioperative care. *Int J Pediatr Otorhinolaryngol*. 2004;68:779-784.
184. De Luca Canto G, Pacheco-Pereira C, Aydinoz S, et al. Adenotonsillectomy complications: a meta-analysis. *Pediatrics*. 2015;136:702-718.
185. The Royal College of Surgeons of England. National prospective tonsillectomy audit. https://www.rcseng.ac.uk/surgeons/research/surgical-research/docs/National%20Prospective%20Tonsillectomy%20Audit%20Final%20Report%202005.pdf. Published 2005. Accessed April 2016.
186. Mueller J, Boeger D, Buentzel J, et al. Population-based analysis of tonsil surgery and postoperative hemorrhage. *Eur Arch Otorhinolaryngol*. 2015;272:3769-3777.
187. Schrock A, Send T, Heukamp L, et al. The role of histology and other risk factors for post-tonsillectomy haemorrhage. *Eur Arch Otorhinolaryngol*. 2009;266:1983-1987.
188. Tunkel DE, Hotchkiss KS, Carson KA, et al. Efficacy of powered intracapsular tonsillectomy and adenoidectomy. *Laryngoscope*. 2008;118:1295-1302.
189. Koltai PJ, Solares CA, Mascha EJ, et al. Intracapsular partial tonsillectomy for tonsillar hypertrophy in children. *Laryngoscope*. 2002;112:17-19.
190. 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.
191. Vicini C, Eesa M, Hendawy E, et al. Powered intracapsular tonsillotomy vs conventional extracapsular tonsillectomy for pediatric OSA: a retrospective study about efficacy, complications and quality of life. *Int J Pediatr Otorhinolaryngol*. 2015;79:1106-1110.
192. Gorman D, Ogston S, Hussain SS. Improvement in symptoms of obstructive sleep apnoea in children following tonsillectomy versus tonsillotomy: a systematic review and meta-analysis [published online August 10, 2016]. *Clin Otolaryngol*.
193. Kristensen S, Tveteras K. Post-tonsillectomy haemorrhage: a retrospective study of 1150 operations. *Clin Otolaryngol Allied Sci*. 1984;9:347-350.
194. Levine M, Ioannidis JPA, Haines AT, et al. Harm (observational studies). In: Guyatt G, Rennie D, Meade MO, Cook DJ, eds. *Users' Guides to the Medical Literature: A Manual for Evidence-Based Clinical Practice*. 3rd ed. New York, NY: McGraw-Hill Education; 2015.
195. Chou R, Aronson N, Atkins D, et al. AHRQ series paper 4: assessing harms when comparing medical interventions. AHRQ and the effective health-care program. *J Clin Epidemiol*. 2010;63:502-512.
196. Gonzalez LP, Pignaton W, Kusano PS, et al. Anesthesia-related mortality in pediatric patients: a systematic review. *Clinics (Sao Paulo)*. 2012;67:381-387.
197. van der Griend BF, Lister NA, McKenzie IM, et al. Postoperative mortality in children after 101,885 anesthetics at a tertiary pediatric hospital. *Anesth Analg*. 2011;112:1440-1447.
198. American Society of Anesthesiologists. ASA physical status classification system. https://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system. Accessed October 11, 2016.