ORL

ORL 2013;75:123–132
DOI: 10.1159/000342314
Published online: August 22, 2013

0301–1569/13/0753–0123$38.00/0
www.karger.com/orl

Hemorrhage after Tonsillectomy: Does the Surgical Technique Really Matter?

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Key Words
Tonsillectomy · Surgery · Technique · Meta-analysis

Abstract
A thorough review of the publications on surgical techniques used for tonsillectomy is provided, emphasizing randomized studies and meta-analysis. In the assessment of the data it is important to clearly define and categorize the types of posttonsillectomy bleeding (PTB), as well as the various factors that have been associated with increased PTB. In recent audits of a large number of tonsillectomies, the PTB rates seem to concur: 1% early and 2.5% delayed PTB; 10% anamnestic, 2% objective, and 2% re-operation PTB. Objective PTB rates beyond 10% should require an audit. The bipolar technique seems associated with the least early PTB, while the cold technique is associated with the least delayed PTB. Because of the lack of large well-conducted randomized trials, it is difficult to conclude which technique is the best. With electrocautery techniques, the current power should be adjusted to the minimal level providing hemostasis. Surgical techniques for tonsillectomy that should probably be abandoned include monopolar electrocautery, Coblation, various lasers, and the harmonic scalpel. Vessel-sealing systems might hold promise and deserve further evaluation. Tonsillotomy might be associated with less postoperative pain, but the hemorrhagic advantage in randomized studies is not obvious. Tonsil regrowth rates and efficacy to treat obstruction need also further evaluation.

The goal of tonsil removal is to treat a disease process for which the tonsils are held responsible, while minimizing postoperative complications. Although the rationale and evidence for the different indications of tonsillectomy are reviewed in another paper of this

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issue [Gysin et al., this issue], it is important to emphasize that minimizing complications should not impede the cure of the disease process. Nowadays, the main reasons for tonsillar ablation in children are hypertrophy and less frequently recurring infections and therefore the goals of the surgical procedure are the amendment of airway obstruction from hypertrophic tonsils and the decrease in pharyngeal infections, respectively.

Complications of tonsillectomy are summarized in table 1 and include a variety of rare but potentially serious events [1–3]. Complications could be divided according to the time frame of their occurrence into intraoperative, early postoperative (within the first 24 h), delayed postoperative (3 weeks) and long term [4]. Frequent complications include postoperative nausea and vomiting and postoperative pain [Czarnetzki and Tramèr, this issue]. By far the most fearsome complication is postoperative hemorrhage (posttonsillectomy bleeding, PTB), which is most often self-limited but could be serious and on extremely rare occasions fatal [5].

Early postoperative bleeding was thought to result from suboptimal operative hemostatic techniques, while delayed bleeding was seen as an unavoidable complication from the shedding of fibrin scabs and was believed to be independent of the surgeon and the surgical technique. Unfortunately little progress has been achieved in the physiopathology of PTB and especially the peculiarities of mucosal scar healing and its possible relation to bleeding.

Incidence of PTB

The incidence of PTB is often cited as extremely variable in the literature. A literature review performed in 2003 found 63 studies reporting on PTB with a mean rate of 4.5 ± 4.7% [6], allowing the author to conclude that PTB rates above 14% (2 standard deviations) justify monitoring. The British National Prospective Tonsillectomy Audit, reporting on close to 12,000 patients found a PTB rate of 3.3% of which 0.5% were early PTB and 2.8% were delayed PTB [7]. A similar prospective audit from Wales on 17,800 procedures reports on a PTB rate of 3.4% of which 0.8% were early PTB and 2.6% were late PTB [8]. In the registry of the Swedish ORL Association, an early PTB was found in 1.3% of 55,000 patients [9]. So PTB rates in these large cohorts seem comparable, with about 1% early bleedings and 2.5% of delayed bleedings, the total PTB rate being about 3.5% (table 2).

The variability of PTB is largely due to the lack of an exact definition of a bleeding episode. In prospective studies [10] bleeding severity is often divided into anamnestic bleeding, observed bleeding, and bleeding requiring reoperation. Reoperation is probably the most adequately reported group with rates around 2% (table 2) in large cohorts [7, 8]. Recently, Sarny et al. [11] elaborated on this idea and proposed a more detailed and precise classification of PTB that could become a standard in future reporting. Overall, 15% of patients experienced some form of PTB, half of which were anamnestic bleedings, one fifth objective PTB, and 30% required reoperation. While these bleeding rates are clearly higher, especially in the anamnestic category, they are possibly explained by the prospective nature of the study, more stringent definition criteria, and a closer follow-up.

The role of public health agencies in the monitoring of health care is expanding but otolaryngology seems to have been spared so far. Because of the dramatic psychological consequences of a child's death, tonsillectomy has become subject to much recent attention. Acceptable rates for PTB are probably around 10% anamnestic, 2% objective, and 2% reoperation (table 2). Clearly anamnestic PTB rates are underestimated in most reports since some patients do not seek medical advice at all or visit another surgeon or hospital [12]. This is probably of little importance, since these episodes are self-limited. At the other end of the

Table 1. Complications of tonsillectomy

Intraoperative	– Laryngospasm and/or bronchospasm – Aspiration – Trauma: tooth fracture, perioral burns, Grisel syndrome, subcutaneous emphysema, subcondylar mandible fracture – Uncontrollable hemorrhage
Early postoperative (<24 h)	– Nausea and vomiting – Pain – Bleeding – Edema of the uvula – Airway obstruction – Postobstructive pulmonary edema
Delayed postoperative (2–21 days)	– Pain – Dehydration – Bleeding – Tonsillectomy bed infection – Neck infections: neck abscess, necrotizing fasciitis, cervical osteomyelitis
Long-term	– Velopharyngeal insufficiency – Pharyngeal stenosis – Tonsillar remnants – Subacute endocarditis – Cranial nerve lesions – Taste disturbances

Table 2. Incidence (%) of PTB

Study	n	Chronology of PTB		Severity of PTB		
		early	delayed	anamnestic	observed	reoperated
Wei et al. [14]	4,662	0.02	2		1	1
British audit [7]	11,796	0.5	2.9		1.3	2.04
Wales audit [8]	17,480	0.8	2.6		1.9	1.5
New Zealand audit [16]	4,546	0.6	1.8			
Arnoldner et al. [15]	6,400	0.26	1.5			1.76
Sarny et al. [11]	9,405			7.5	3	4.5

spectrum, reoperation PTB rates of 19%, as recently published [12], are inacceptable and mandate some form of monitoring/auditing. Hopefully, national ORL societies will step in the evaluation, guidance and regulation, prior to the involvement of public health services.

Factors Associated with PTB

Besides surgical technique and perioperative medications, several other parameters have been associated with increased PTB. These include the patient's age [8, 9, 11, 13–15], male gender [8, 9, 15], infections as indication for tonsillectomy [9], less experienced surgeon [8, 11, 13] and the period during which surgery was performed [9, 16].

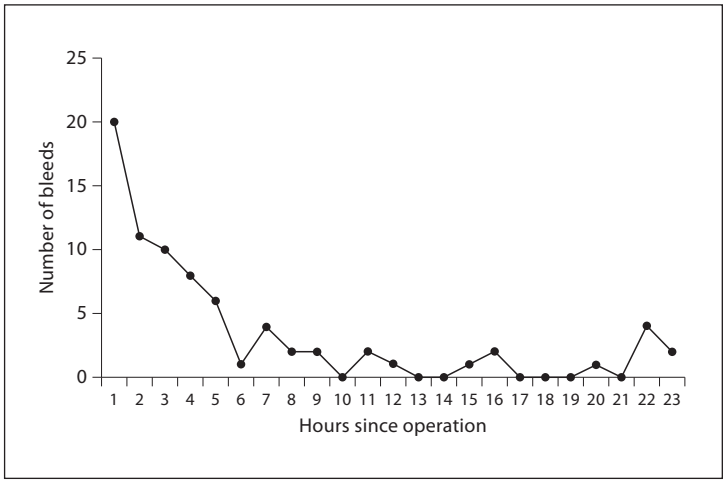

Fig. 1. Timing of PTB (reproduced with permission from Bennett et al. [17]).

Clearly, young children (<6 years) have less PTB than adolescents or adults. An interesting age-sex distribution is described by Tomkinson et al. [8], with a male peak incidence of PTB around 10 years and a female peak incidence of PTB around 20 years.

In Sweden there has been a progressive decline of early PTB, attributed by the authors to the increased prevalence of the tonsillotomy surgical techniques [9]. In contrast, there was an increase in PTB in New Zealand in recent years, which was attributed by the authors to the systemic administration of nonsteroidal anti-inflammatory drugs and steroids [16].

Obviously these risk factors and especially age and indications should be included as stratification variables in studies comparing different surgical tonsillectomy techniques. To this should be added the recent controversy about the role of steroids and nonsteroidal anti-inflammatory drugs [10] on the rate of PTB. Needless to say that even prospective randomized trials on surgical techniques have rarely accounted for such potential biases.

Timing of PTB

The duration of hospitalization has followed the downwards trend of other procedures: from a hospitalization duration of about a week during the 1960s to an ambulatory procedure. While some patients with malformations and comorbidities should be considered on an individual basis, there is no evidence that PTB should prevent outpatient tonsillectomy. Bennett et al. [17] performed a meta-analysis of the timing of PTB, including 16 studies reporting on 27,305 patients: a PTB rate of 1.26% was found between 0 and 8 h and one of 0.12% between 8 and 24 h (fig. 1).

Surgical Technique: Cold or Bipolar

Tonsillotomy or partial removal of the tonsil is the ancient method of tonsil removal, going back to Celsius in ancient Rome [18]. The first complete tonsillectomy was apparently performed by Edwin Pynchon in Chicago, in 1890 [18], and in the early 20th century the complete tonsillectomy technique was popularized and preferred because of the problems associated with tonsillotomy, such as persistence of infections, tissue regrowth, and need for several operations [18]. Even if some form of electrocautery was already used by Pynchon,

the use of electrosurgical devices did not become popular until the 1960s, awaiting progress of anesthesia techniques which allowed endotracheal pediatric anesthesia with nonflammable anesthetic agents [19]. The initial devices used monopolar electrocautery, and this technique still remains one of the most popular techniques in North America [20] but its use in Europe is limited [21]. Monopolar cautery is not recommended over bipolar cautery because it does not provide any hemostatic advantage [21] and is associated with increased pain [22].

The first bipolar technique tonsillectomy report was published in 1974 [23]. In the mid-1990s we set to compare the bipolar microscopic tonsillectomy described by Andrea [24] to the traditional cold dissection in a prospective double-blind randomization. The double-blind approach could be justified since the evaluation was performed by a physician (C.G.) unaware of the surgical technique [25]. Patients were kept overnight in the hospital and no early PTB was present in either group. Delayed PTBs were found in 5.5% of patients, distributed into 2% anamnestic PTB, 3% observed PTB and 0.5% reoperation PTB. This single reoperated patient had a cold tonsillectomy. There was no statistically significant difference in PTB among the two groups. Nevertheless, this is one of only two studies (the other used monopolar cautery) included in a hot versus cold Cochrane collaboration review, the conclusion of which states that 'data are insufficient to state that one technique is better than the other' [26].

So the British audit [7] outcome according to the surgical technique of tonsillectomy was quite a surprise. According to their data, cold tonsillectomy was the surgical technique associated with the lower rate for observed and reoperation PTB. We were happy to see that the safest technique for early PTB is bipolar forceps (0.37 vs. 0.60%). However, for delayed PTB, cold techniques appear the best (0.75 vs. 3.63%).

There were several problems with this study: (1) even if 12,000 patients were included, this is not a randomized trial and theoretically the level of evidence for potential conclusions is not very high; (2) the age distribution of the population undergoing tonsillectomy seems different from our experience and more importantly the difference in PTB (>5 years: 2.2%; 5–15 years: 2.7%, and >15 years: 4.5%) is not statistically tested and not assessed in a multivariate statistical analysis; (3) a probably related problem is the tonsillectomy indication, with PTB differences (obstruction: 1.4%, and recurrent tonsillitis: 3.5%) not statistically tested and not assessed in a multivariate statistical analysis. Some of these problems were addressed in a later publication [21].

Nevertheless, this study weighted heavily on the British NHS NICE assessment [27] which concluded: 'The clinical choice would seem to be between an increased risk of secondary haemorrhage with electrosurgery compared with cold steel dissection with ties/packs haemostasis or an increase in the risk of primary haemorrhage with cold steel dissection with ties/packs haemostasis compared with electrosurgery.'

To conclude, at the present time, the question of the safest technique of tonsillectomy remains unanswered. Whether traditional cold tonsillectomy or bipolar tonsillar dissection or the intermediate variant, namely cold tonsillectomy with bipolar coagulation for hemostasis, is the safest technique is unclear. The cold technique is favored by a large audit and a national recommendation to be the safest technique in delayed PTB. Bipolar tonsillectomy seems to be associated with the lowest early PTB rate in this audit and has been found as safe in the only randomized double-blind trial on the subject [25].

Unfortunately, the surgical techniques are far from being standardized. A cold technique dissection is a straightforward technique in children with tonsillar hypertrophy; however, we find it almost impossible to perform only cold dissection (without any electrical hemostasis) in inflamed and scarred tonsillar fossae in adults. So when cold dissection and bipolar cauterization are included, the distinction between the two techniques becomes quite blurred.

Regarding bipolar tonsillectomy or cauterization, we can only concur with the conclusions of Lowe et al. [28] that the diathermy power should be set to the minimum possible to achieve hemostasis.

Finally, there are several advantages to microscopic bipolar tonsillectomy that have been disregarded in the debate: (1) beginning the surgery at the inferior pole of the tonsils where the majority of serious PTBs occur, (2) great visualization and illumination provided by the microscope, (3) preventive control of the bleeding by the bipolar device [25].

Surgical Technique: Coblation

Coblation® is a registered trademark by a surgical instruments company. The term was coined as shortening for cold ablation. It uses a bipolar radiofrequency current which, when passing through a conductive medium such as saline or body fluids produces a plasma field, the ions of which can break molecular bonds and disintegrate tissue at low temperatures.

A recent Cochrane collaboration review [29] could include 9 trials comparing Coblation tonsillectomy to other tonsillectomy techniques. The reviewers concluded that 'all but two studies were of low quality and therefore a meta-analytical approach was not appropriate. In most studies, when considering most outcomes, there was no significant difference between Coblation and other tonsillectomy techniques' [29]. For early PTB the incidence in studies varied from 0 to 28%, with no significant difference between tonsillectomy techniques. For delayed PTB the incidence in studies varied from 0 to 50%, and in 7 studies no significant difference between tonsillectomy techniques was found, while 1 study found less bleeding in the standard treatment group.

Another meta-analysis [30] looked at the rates of PTB in Coblation tonsillectomy publications and concluded to 0.9 ± 0.4% early PTB, 3.6 ± 0.7% delayed PTB, and 4.1 ± 0.7% overall PTB. These bleeding rates are above the averages in table 2 and the authors, who have been supported by the manufacturer, seem quite biased. Coblation has been associated with the highest PTB rates in the British [7], Wales [8] and Austrian [11] audits, especially for the delayed PTB.

Coblation is an elegant technique reuniting the majority of conditions for low tissue damage by the dissecting electric current; however, the lack of demonstrated benefit for tonsillectomy and the cost of the disposable device do not herald great promise for its use in this procedure.

Surgical Technique: Other Methods

A variety of other techniques have been applied to the removal of tonsils, including bipolar scissors, various lasers, the harmonic scalpel and 'vessel-sealing systems' (LigaSure®, Thermal Welding®, BiClamp®). The microdebrider is also used but for tonsillotomy.

Bipolar scissors were compared to cold dissection in two studies with questionable randomization (table 3). In Raut et al. [31], there were numerous anamnestic PTBs and no reoperations. The difference in PTB between groups was not statistically significant. In Heyden et al. [32] there was 7.7% delayed PTBs and 5.1% reoperations. In the British audit, bipolar scissors used at the level of bipolar forceps, with 0.8% early PTBs, 3.4% late PTBs and 3% reoperations, with a statistically significant disadvantage relative to the cold technique [7]. We like bipolar scissors tonsillectomy but find that it is not the initial technique to teach junior residents.

Table 3. PTB in various techniques in randomized prospective studies

Technique	Authors	n	Reference technique	Statistical significance	Chronology of PTB, %		Severity of PTB, %		
					early	delayed	anamnestic	observed	re-operated
Bip. scissors	Raut et al. [31]	18	cold	NS	2	16.6	10	8	0
Bip. scissors	Heyden et al. [32]	78	cold	???	0	7.7	0	2.6	5.1
Laser – argon	Bergler et al. [36]	66	cold + bip.	NS	0	16.6	?	13.6	3
Laser – KTP	Kothari et al. [34]	79	cold	NS	11	8	?	8	0
Laser – KTP	Hegazy et al. [35]	40	RF	NS	0	2.5	?	2.5	0
Laser – argon	Ferri and Armato [33]	109	cold	NS	0	5.5	?	4.6	1
VSS – Ligasure	Attner al. [40]	75	bip. scissors	NS	0	10.61	?	9.3	1.3
VSS – Ligasure	Lachanas et al. [41]	108	cold	NS	0	1	?	1	0
VSS – thermal welding	Karatzias et al. [42]	81	bip.	NS	0	4.9	2.5	2.5	0
VSS – thermal welding	Sezen et al. [43]	81	cold	NS	0	0	?	0	0
VSS – thermal welding	Stavroulaki et al. [44]	16	cold	NS	0		?	0	0

n = Number of subjects in test group; PTB = incidence of PTB in the tested surgical technique only; RF = radiofrequency; bip. = bipolar, NS = not significant; VSS = vessel-sealing system.

The remaining techniques/devices were used only in 4.2% of tonsillectomies in the British audit [21]. Few good randomized studies (table 3) have compared laser tonsillectomies to other techniques [33–36] and although the PTB rates are not significantly different, they tend to be higher than the comparison group. Overall, there are few good reasons to select lasers as a tonsillectomy technique and disadvantages include cost, increased pain, and a prolonged healing phase. When selecting a laser for tonsillectomy, the ubiquitous CO_2 laser is not a good choice due to its poor hemostatic properties, and other lasers, such as KTP, argon or thulium should be preferred. These lasers tend to be more expensive and less readily available.

The harmonic scalpel uses ultrasonic energy to vibrate the dissection blades. The vibration transfers energy to the tissue between the blades and leads to coagulation of proteins and tissue destruction. In the process, the neighboring tissue reaches a temperature of 80°C. In a recent meta-analysis of randomized controlled trials of harmonic scalpel tonsillectomies versus 'conventional' techniques, Alexiou et al. [37] found an odds ratio of 0.78 (CI 0.50–1.23) in favor of the harmonic scalpel in terms of PTB (details on the type of PTB not provided). These nonsignificant results in close to 1,500 patients, coupled to the lack of analgesic advantages and to the cost of device, make us conclude that the harmonic scalpel is not a promising tool for tonsillectomy.

The 'vessel-sealing systems' use different proprietary hand pieces coupled to electrocautery delivery systems and algorithms. The general principle is to measure the tissue impedance between the blades of the hand pieces and adjust (minimize) the intensity of the electric current delivered. The advantages of these systems in other applications is to seal large vessels up to several (5) millimeters. The meta-analysis of Alexiou et al. [37] found 7 randomized trials including 780 patients with these techniques: the rate of PTB was 1.7 vs. 6.9% with the traditional techniques, a statistically significant difference favoring the vessel-sealing systems (odds ratio –1.73 with CI –3.1 to –0.4). Furthermore, this meta-analysis found that vessel-sealing systems were associated with a significantly shorter operating time, lesser perioperative bleeding, and lesser postoperative pain. However, among these 7 studies the comparison 'traditional' group was composed of monopolar electrocautery in 3 instances and the harmonic scalpel in 1, and therefore the results should be interpreted with caution. The

studies that used vessel-sealing systems and used either cold or bipolar techniques as a control group are summarized in table 3. No early postoperative bleeding was noted in either study attesting to the excellent intraoperative hemostasis. There were few delayed PTBs and most of them did not require a reoperation. None of these studies provided a statistically significant difference of PTB between the two arms. In conclusion, vessel-sealing systems probably achieve reliable hemostasis and are associated with very low PTB and a low delayed PTB, especially for reoperation. Although these tonsillectomy techniques might be promising, we were not impressed by the quality of the published studies.

Surgical Technique: How Much Tonsil to Remove?

Tonsillotomy is the removal of some tonsillar tissue. No specific definition of how much tonsillar tissue is removed is found in the literature. In addition, it is assumed that the tonsillar capsule remains intact but again that is rarely specified. In the literature tonsillotomy is sometimes referred to as 'partial tonsillectomy' or 'intracapsular tonsillectomy'; these are poor synonyms that should be avoided.

Recently, a meta-analysis of randomized trials [38] and a systemic review, which also included nonrandomized studies [39], comparing tonsillotomy with traditional tonsillectomy, were published. According to Walton et al. [38] in randomized trials early PTB was present in 3/699 (0.4%) tonsillotomy and 1/635 (0.16%) tonsillectomy patients, a nonsignificant difference. Delayed PTB was found in 5/699 (0.7%) tonsillotomy and 13/635 (2.0%) tonsillectomy patients, a statistically significant difference ($p = 0.04$). Unfortunately the details of the PTB were not specified. Acevedo et al. [39] found an odds ratio of PTB for tonsillotomy of 0.77 compared to tonsillectomy, with a nonsignificant difference. When poorer studies were included (nonrandomized trials, trials with larger or unspecified loss to follow-up), the difference in favor of tonsillotomy became significant.

In randomized trials, pain was less and return to normal diet shorter [38, 39]. The majority of included patients were children with tonsillar hypertrophy and/or obstruction with sleep consequences. Walton et al. [38] concluded that, in children with hypertrophic tonsils, there was enough evidence for 'equivalent or superior recovery-related outcome' in tonsillotomy versus tonsillectomy. Acevedo et al. [39] concluded that 'tonsillotomy appears to be a safe technique that may offer some advantages over tonsillectomy in terms of postoperative morbidity, but differences in hemorrhage and dehydration were not evident in high-quality studies. Data regarding tonsil regrowth rates and efficacy in treating sleep-disordered breathing are not yet sufficient for formal analysis, which may preclude widespread acceptance of this technique.'

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