

Bleeding after tonsillectomy was associated to hypertension and dissection with diathermy, but not surgical experience

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Abstract

Objective: To analyze risk factors for postoperative bleeding after tonsillectomy (TE), and differences in bleeding frequency between 2017 and 2018.

Study design: This is a retrospective cohort study.

Setting: The Department of Otorhinolaryngology – Head and Neck Surgery, region of Östergötland, Sweden.

Methods: This retrospective cohort study included all 402 consecutive cases of TE in the region of Östergötland, Sweden 2017–2018. Patients were followed for at least 30 days after surgery. Demographics, comorbidity, surgical experience, potential risk factors and postoperative complications were registered. The primary endpoint was postoperative bleeding.

Results: Twenty-four of 402 (6%) patients had a postoperative bleeding after tonsillectomy. Hypertension and dissection with bipolar diathermy respectively were identified as independent, statistically significant risk factors for bleeding, in both uni- and multivariate analysis. Surgical experience was not significantly associated to bleedings after TE.

Conclusion: Hypertension and dissection with bipolar diathermy are individual risk factors for postoperative bleeding following tonsillectomy, but not surgical experience.

Introduction

According to the National Tonsil Surgery Register in Sweden (NTSRS), 54.524 tonsil surgeries were registered 2015–2019, averaging 10.900 per year [1]. Tonsillectomies (TE) were more common than tonsillotomies (TT) (TE 55%, TT 45%), and the majority of the patients were children and young adults. High age [2,3], male gender [2,4,5], hypertension [6], surgical indication [2], use of local anesthesia with adrenaline [7], smoking [8,9], high BMI [10] and ADHD [11], were risk factors for postoperative bleeding, according to the literature. An increased number of bleedings was reported between 1987 and 2013 [12], when ‘hot surgical techniques’ gained wider spread. During later years, a return to ‘cold surgical techniques’ [2,13], and an increased number of TTs [14], have led to stable numbers of postoperative bleedings [15]. Convincing evidence indicate that dissection using cold steel instruments causes less postoperative bleeding than hot techniques such as bipolar diathermy, coblation, radiofrequency or ultracision [16,17].

TE is a common surgery in Sweden, generally performed as an outpatient procedure. Postoperative bleeding causes personal suffering, often necessitating readmission and sometimes re-operation. Furthermore, bleedings are associated with costs for acute transportation, surgery, and hospitalization and a deeper understanding of preventable factors affecting the risk of bleeding is called for. A recent study using data from the NTSRS showed that, 4.5% of the patients having tonsil surgery in Sweden were re-hospitalized because of bleeding within 30 days, (TT 1.1% and TE 8.6%) 2009–2018 [15]. NTSRS data for the region of Östergötland (RÖ)

showed an unexplained difference in the rate of rehospitalization after tonsillectomy 2017 (10.8%) versus 2018 (2.6%) [1]. The aim of this study, was to analyze risk factors for postoperative bleeding after TE, using demographics, comorbidity, indication, methods for surgery and hemostasis, surgeon experience, and differences in rehospitalization rates 2017 and 2018.

Methods

Patients were identified using surgical codes registered in the electronic medical records, for all patients undergoing tonsil surgery during 2017–2018, in RÖ, Sweden. The region includes one regional and one university hospital. Patient medical charts were reviewed and parameters potentially influencing the risk of bleeding were collected (Table 1). Ethical approval was obtained from the regional ethics board, (2019-03687), and data has been handled according to Swedish law and regulations.

None of the TT patients in 2017 (109) suffered postoperative bleeding and were therefore excluded. Further analysis was made on the 402 patients having TE with or without other concurrent surgery.

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Table 1. Univariate analysis comparing patients with and without postoperative bleeding. Age presented as the median (lower and upper quartile). Other variables are presented as numbers (percentages).

	Reference group n=378	Post-op bleeding n=24	P
Baseline characteristics			
Age	23 (15;40)	26.5 (19;52)	0.068
Age < 18 years	123 (32.5%)	2 (8.3%)	0.013
Age ≥ 18 years	255 (67.5%)	22 (91.7%)	
Female	201 (53.2%)	9 (37.5%)	0.136
Male	177 (46.8%)	15 (62.5%)	
Coagulopathy	1 (0.3%)	1 (4.2%)	0.116
Hypertension	16 (4.2%)	6 (25.0%)	0.001
Diabetes	8 (2.1%)	1 (4.2%)	0.429
ADHD	5 (1.3%)	1 (4.2%)	0.311
Smoking	31 (8.2%)	5 (20.8%)	0.056
Overweight (all)	171 (45.2%)	15 (62.5%)	0.124
Oral anticoagulants	12 (3.2%)	2 (8.3%)	0.201
Previous TT	15 (4.0%)	0 (0.0%)	1.000
Postoperative infection	13 (3.4%)	3 (12.5%)	0.057
Surgical indication			
Obstruction	44 (11.6%)	3 (12.5%)	0.752
Chronic tonsillitis	123 (32.5%)	7 (29.2%)	0.732
Acute/former peritonsillar abscess	101 (26.7%)	5 (20.8%)	0.526
Complication of systemic illness	2 (0.5%)	0 (0.0%)	1.000
Suspected malignancy	67 (17.7%)	5 (20.8%)	0.783
Other indication	17 (4.5%)	3 (12.5%)	0.109
Surgical method			
Cold steel	353 (93.4%)	22 (91.7%)	0.670
Coblation w RF	12 (3.2%)	0 (0.0%)	1.000
Dissection with diathermy	3 (0.8%)	2 (8.3%)	0.031
Method of hemostasis			
Compression	310 (82.0%)	20 (83.3%)	0.767
Bipolar diathermy	334 (88.4%)	24 (100%)	0.241
Ligature	23 (6.1%)	5 (20.8%)	0.022
Local anesthetic w adrenalin	284 (75.1%)	16 (66.7%)	0.443
Tranexamic acid	27 (7.1%)	3 (12.5%)	0.155
Miscellaneous			
TE à chaud	43 (11.4%)	2 (8.3%)	1.000
Regional hospital	267 (70.6%)	16 (66.7%)	0.680
University hospital	111 (29.4%)	8 (33.3%)	
Operating time only TE	36 (28;46)	34 (31;50)	0.932

The patients who suffered postoperative bleeding were compared to non-bleeding patients. No distinction regarding early or late hemorrhage was made, thus all hemorrhages resulting in some sort of intervention immediately after anesthesia up to 30 days postoperatively were included. Patients who only suffered minor problems with blood-mixed saliva postoperatively and returned home as planned were not included.

Since the majority of patients were children or young adults, we evaluated if age affected the risk of bleeding. All patients at least 18 years of age were categorized as adults. In addition, any potential difference between the sexes was analyzed, as well as differences in patient selection and surgical indication. The surgical indications were divided into the following categories: obstruction, chronic or recurring tonsillitis, acute/former peritonsillar abscess, complication of systemic disease, suspected malignancy and 'other indication' (such as branchial cleft cysts).

We also wanted to evaluate if the experience of the surgeon could affect the risk of postoperative bleeding. Surgeons were divided into the

following categories: 'Junior resident', 'Senior resident' and Specialist/Consultant. The cut off between junior and senior resident was 30 out of the 60 months of clinical experience required to become a specialist. Furthermore, operating time was evaluated for patients who only had TE (thus excluding those with other concurrent surgery). Surgical techniques and methods of hemostasis were analyzed and divided into cold steel, coblation with radiofrequency and dissection with diathermy. Emergency tonsillectomy due to peritonsillar abscess (TE à chaud) was suspected to increase the risk of bleeding and was therefore documented. Methods of hemostasis were divided into compression, diathermy, ligature, and local anesthesia with adrenaline. Use of tranexamic acid was also recorded.

We recorded the prevalence of smoking, BMI, comorbidity and previous surgeries in the area, e.g. previous TT for all patients. Since children's reference values for BMI vary widely with age, the measure of ISO-BMI was used to categorize patients as normal weight or overweight (including obesity and severe obesity). In order to enable analysis of the entire material the adults were also categorized as normal (BMI<25) or overweight (BMI ≥ 25). The following comorbidity variables were included: Hypertension, oral anticoagulants, coagulopathies, diabetes, and ADHD.

The primary outcome measure was postoperative bleeding. Secondary outcome measures were postoperative infection, bleeding causing readmission, number of extra days in hospital, time until bleeding, reoperation in general anesthesia, and comparing bleedings in 2017 with 2018.

Statistical methods

Continuous variables were summarized as medians with lower and upper quartile. Their distributions were tested with the Shapiro-Wilks test. Normally distributed data was analyzed with Student's t-test, non-normally distributed data with the Mann-Whitney U test. Categorical variables were presented as numbers and percentages and analyzed with the Chi-Square-test, or Fisher's exact test when at least one cell had an expected value less than 5. A logistic regression analysis was carried out to identify risk factors associated with bleeding. The parameters that individually met $p < 0.1$ were included to analyze their association to each other. In the case of a significant association with a Pearson correlation test the parameter least associated with postoperative bleeding was removed. Thereafter, backward stepwise regression was carried out, in which the weakest variable of the model was removed in each step until only variables with $p < 0.05$ remained. A linear regression analysis was used for the continuous variables age and BMI for adults. A p -value < 0.05 was considered statistically significant. Adults and children were analyzed together as well as separately.

Results

Of the 402 patients who underwent TE during 2017-2018, 24 had postoperative bleeding (6.0%) (Table 1). Postoperative infection occurred in 16 patients (4.0%).

The number of readmissions due to bleeding was 23 (5.7%) and resulted in 27 extra days in hospital. The median time until bleeding occurred was 5.5 days postoperatively. Ten cases required reoperation in surgical theatre (2.5%).

When comparing the bleeding group with the reference group using univariate analysis, statistically significant differences were identified for age ≥ 18 years ($p=0.013$), hypertension ($p=0.001$), dissection with diathermy ($p=0.031$) and hemostasis with ligature ($p=0.022$). Other

parameters close to statistical significance were smoking (p=0.056) and postoperative infection (p=0.057). After multivariate regression analysis only hypertension and dissection with diathermy remained significant risk factors, with odds ratios of 7.07 (95% confidence interval: 2.39; 20.91) and 9.55 (1.32; 68.92) respectively (Table 2). The continuous variables age and BMI for adults were not significantly correlated to risk of bleeding in a linear regression analysis.

Surgical indication did not differ between the bleeding group and the reference group. The median time for surgery with only TE (without other concurrent surgery) was 36 minutes for the reference group and 34 minutes for the bleeding group. The majority of TE was performed with cold technique (93.3%), and 4.0% by dissection with diathermy or coblation. In ten patients, the surgical method did not appear in the medical records.

There was no significant difference in bleeding risk based on surgical experience (Table 3). The category with highest bleeding frequency was specialist/consultant, 14/198 (7.1%), followed by junior resident with 7/101 (6.9%) and lowest for senior resident with 3/103 (2.9%). Median operating time for TE alone was 45 minutes for junior residents, 32.5 minutes for senior residents and 33 minutes for specialists/consultants, indicating that junior residents required significantly more time than more senior colleagues (p=0.000).

In 2017, 17/177 (9.6%) suffered postoperative bleeding and in 2018, 7/225 (3.1%) (p=0.006) (Table 4). Variables that differed between the 2017 and 2018 groups included percentage of patients with hypertension (p=0.001) and ligation (p=0.007). ‘Other indication’ (p=0.053) and coblation (p=0.053) were close to statistical significance.

Discussion and conclusion

Among the 402 patients who underwent TE 2017-2018 the postoperative bleeding frequency within 30 days was 6.0%, similar to the national average of 6.2% for the same period according to NTSRS [1].

A statistically significant correlation to postoperative bleeding was found for age ≥ 18 years, hypertension, dissection with diathermy and ligation in univariate analysis, but only hypertension and dissection with diathermy remained significant after multivariate regression. Cold steel was standard practice, used in 93.3% of the cases in this study. Only five patients underwent surgery using dissection with bipolar diathermy, resulting in two postoperative bleedings (40%), indicating a tenfold risk of bleeding in this very small group. However, the results are in accordance with the sixfold risk of bleeding after dissection with bipolar diathermy demonstrated by Lundström et al. [15] and those

Table 2. Multivariate analysis of risk factors for postoperative bleeding. The significant factors in a multivariate logistic regression analysis with backwards stepwise regression. p-value calculated using Wald test. The following factors were included: Hypertension, Dissection with diathermy, Smoking.

	Odds ratio (95% CI)	p
Hypertension	7.07 (2.39;20.91)	0.000
Dissection with diathermy	9.55 (1.32;68.92)	0.025

Table 3. Univariate analysis comparing patients with and without postoperative bleeding.

Surgeon	Reference group, n=378, (%)	Bleeding, n=24, (%)	p (2x2 Chi-2)	p (3x2 Chi-2)
Junior resident	94 (93.1%)	7 (6.9%)	0.638	0.315
Senior resident	100 (97.1%)	3 (2.9%)	0.129	
Specialist/consultant	184 (92.9%)	14 (7.1%)	0.359	

Table 4. Univariate analysis comparing patients who underwent TE in 2017 to 2018. Age presented as the median (lower and upper quartile). Other variables are presented as numbers (percentages).

	2017 n=177	2018 n=225	p
Bleeding	17 (9.6%)	7 (3.1%)	0.006
Baseline characteristics			
Age	25 (16;44)	22 (15;37)	0.181
Age ≥ 18 years	126 (71.2%)	151 (67.1%)	0.388
Male	85 (48.0%)	107 (47.6%)	0.926
Hypertension	17 (9.6%)	5 (2.2%)	0.001
Diabetes	6 (3.4%)	3 (1.3%)	0.190
ADHD	2 (1.1%)	4 (1.8%)	0.698
Smoking	17 (10.1%)	19 (9.1%)	0.736
Oral anticoagulant	8 (4.5%)	6 (2.7%)	0.314
Overweight	87 (50.9%)	99 (44.6%)	0.216
Postoperative infection	9 (5.1%)	7 (3.1%)	0.309
Indication			
Obstruction	17 (9.6%)	30 (13.3%)	0.248
Chronic tonsillitis	62 (35.0%)	68 (30.2%)	0.306
Acute/former peritonsillar abscess	44 (24.9%)	62 (27.6%)	0.542
Complication of systemic illness	1 (0.6%)	1 (0.4%)	1.000
Suspected malignancy	34 (19.2%)	38 (16.9%)	0.547
Other indication	13 (7.3%)	7 (3.1%)	0.053
Surgical method			
Cold steel	165 (93.2%)	210 (93.3%)	0.964
Coblation w RF	2 (1.1%)	10 (4.4%)	0.053
Dissection with diathermy	3 (1.7%)	2 (0.9%)	0.658
Method of hemostasis			
Compression	151 (88.3%)	179 (82.9%)	0.134
Bipolar diathermy	155 (91.7%)	203 (92.3%)	0.841
Ligation	19 (11.2%)	9 (4.1%)	0.007
Local anesthetic w adrenaline	121 (71.6%)	179 (81.0%)	0.029
Miscellaneous			
TE à chaud	16 (9.0%)	29 (12.9%)	0.224
Regional hospital	126 (71.2%)	157 (69.8%)	0.759
University hospital	51 (28.8%)	68 (30.2%)	
Operating time only TE	35 (27.5;47.5)	36 (29;46)	0.691
Surgeon			
Junior resident	38 (21.5%)	63 (28.0%)	0.134
Senior resident	50 (28.2%)	53 (23.6%)	0.285
Specialist/consultant	89 (50.3%)	109 (48.4%)	0.714

of Söderman et al. [13] where dissection with bipolar scissors was associated with a fourfold increase in risk of bleeding.

Hsueh et al. [6] found that hypertension was associated with a 2.2-fold risk for readmission due to postoperative bleeding in multivariate analysis, compared to a sevenfold increased risk, in our study. It is possible that patients with hypertension have higher pressure in the blood vessels in the tonsillar fossa increasing the risk of bleeding. On the other hand, hypertension was correlated with age, previously shown to be associated with decreased healing capabilities [18], and maybe correlated to comorbidity or lifestyle factors not identified in this study.

Ligation as a hemostatic method was significantly correlated with an increased risk of bleeding (p=0.022), but not after multivariate regression. Ligation is often used during difficult intraoperative bleeding and may therefore be an effect rather than a cause of bleeding. Windfuhr et al. [19] saw similar bleeding rates after hemostasis using bipolar coagulation (5.2%) compared to suture ligation (4.5%) in 3.658 patients who all underwent TE using cold steel. No study compared ligation to simple compression. The hemostatic methods

diathermy and compression were mostly used in our clinic, followed by injection and/or compression with adrenaline, with or without local anesthetic, followed by ligation. None of the hemostatic methods were statistically significant for bleeding after multivariate regression, opposing the results of Söderman et al. [13] showing an increased risk of postoperative bleeding after use of diathermy in a study on 15.000 TE patients.

Smoking was not significant in the multivariate regression analysis, possibly due to the modest sample size. Cinnamon et al. [8] and Seyhun et al. [9] saw significantly higher risks of bleeding after TE in smokers, as did Giger et al. [20] after TE à chaud in smokers. A more rigid anti-smoking recommendation preoperatively could possibly reduce the risk of bleeding after TE, even though smoking was not significantly correlated to bleeding in this study.

Only two of 125 children (1.6%) bled postoperatively compared to 22 of 278 adults (7.9%) ($p=0.013$). Age was associated to bleeding in the univariate analysis, but not in the multivariate analysis, due to its strong correlation with hypertension. Male sex was a risk factor for bleeding according to Coordes and Windfuhr [4,5], but not significant in our study.

Longer surgeries could potentially increase the risk of bleeding, as could the surgeon's experience. TE is often not the only procedure during an operation, but part of combined procedures such as a work-up for a suspected malignancy, neck cyst or adenotonsillectomy. We compared the duration of surgery in patients who only underwent TE to see if there was a difference between patients who bled and others, but no significant difference was found. Duration of surgery could however be a difficult parameter to analyze, since problematic surgery takes more time, or rushed surgery could lead to an increased risk of bleeding.

Elinder et al. [2] saw an increased risk of bleeding in patients with infectious indication for surgery before, but not after, correcting for other factors and Østvoll et al. [12] found that infectious indication was associated with an increased risk of bleeding in uni- and multivariate analysis in a study of 256.000 patients. In this study, no surgical indication was a significant risk factor. The indication peritonsillar abscess, and especially TE à chaud, could theoretically entail a higher risk of bleeding due to the acute inflammation or scarring, but in accordance with our findings, other authors did not find a significantly increased risk of bleeding after TE à chaud either [21,22].

Patient data was evaluated and correlated to the risk of bleeding. Overweight was not significantly associated to an increased risk of bleeding, nor was diabetes, oral anticoagulants, or ADHD. Overweight patients underwent TE more often due to obstruction than repeated infections or suspected malignancy, possibly affecting the risk of bleeding. The median age for patients undergoing TE was relatively low (23 years) and comorbidity hence low. We could not reproduce the results of Hoshino et al. [10] who saw increased risk of bleeding in overweight patients or Spektor et al. [11] who saw an increased risk of bleeding in ADHD patients and older children compared to younger.

Surgical experience had no significant impact on bleeding risk. However, it can be speculated that patient groups differed, and that specialists to a larger extent operated on cancer patients with heavy comorbidity or emergency operations, while residents operated on otherwise healthy and younger patients. It is still an interesting finding, that surgical experience did not influence the risk of bleeding in this study.

Postoperative bleeding is an uncomfortable experience for the patient as well as the doctor and a potentially lethal complication.

Twenty-three patients were readmitted due to postoperative bleeding (5.7%), resulting in 27 extra days in hospital, and 10 cases of reoperation (2.5%). Readmission, rehospitalization and reoperation, causes not only personal suffering for the patient, but it is also costly. These costs are however still cheaper than inpatient tonsillectomies with several days of postoperative hospital care that used to be the norm 20 years ago. Furthermore, bleeding complications in this study occurred at day 5 in median, indicating that one or two nights at the hospital postoperatively would not increase safety for the patient.

The bleeding frequency increased in 2017 (9.6%) and decreased below national average in 2018 (3.1%). We found a significantly higher percentage of hypertensive patients in 2017 (9.6%) compared to 2018 (2.2%) and ligation was used more often 2017 (11.2%) than 2018 (4.1%). Variation in patients' comorbidity and hemostasis methods could explain the differences between bleeding frequencies in 2017 and 2018. High numbers of postoperative bleedings in 2017 also sparked a debate on techniques and hemostasis methods among doctors at the clinic, possibly contributing to the low numbers of bleedings in 2018.

In conclusion, hypertension and dissection with diathermy significantly increased the risk of postoperative bleeding after TE. Interestingly, the experience of the surgeon did not affect the risk of bleeding postoperatively. We believe that awareness about surgical techniques, and extra caution concerning hypertension could affect the number of postoperative bleedings.

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