

# Hemorrhage Following Tonsil Surgery: A Multicenter Prospective Study

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**Objectives/Hypothesis:** Postoperative hemorrhage as a serious complication after tonsillectomy (TE), tonsillotomy (TO), or adenoidectomy (AE) is covered in many studies, using rather inconsistent measurement methods. We introduce a new classification for the severity of postoperative hemorrhage and investigate risk factors for the frequency and severity of bleeding episodes.

**Study Design:** Prospective, multicenter cohort study.

**Methods:** Our study is based on a prospective census recording all TEs, TOs, and AEs from October 1, 2009, to June 30, 2010, in Austria. Information concerning surgery indication, grade of surgeon, operation technique, and postoperative hemorrhage, classified as any bleeding episode after extubation according to severity, were collected.

**Results:** A total of 9,405 patients were included. Hemorrhage rate for TE  $\pm$  AE was 15.0%, for TO  $\pm$  AE was 2.3%, and for AE was 0.8%. Rate of return to the operating room for TE  $\pm$  AE was 4.6%, for TO  $\pm$  AE was 0.9%, and for AE was 0.3%. Minor bleeding episodes increased the risk of a subsequent severe bleeding episode ( $P < .001$ ). Elevated hemorrhage rates were observed for adults ( $P < .001$ ), TE  $\pm$  AE ( $P < .001$ ), and cold steel dissection combined with bipolar diathermy ( $P = .05$ ). Multivariate logistic regression model for the frequency of post-TE hemorrhage showed significant odds ratios for males, children aged  $<6$  years, children aged 6–15 years, abscess TE, and cold steel combined with bipolar diathermy. In addition, we found a significantly higher risk of severe bleeding episodes for children aged 6–15 years ( $P = .007$ ), males ( $P = .02$ ), and all bipolar operation techniques ( $P = .005$ ).

**Conclusions:** The occurrence of a postoperative minor bleeding episode increases the risk of a subsequent severe bleeding episode.

**Key Words:** Tonsillectomy, tonsillotomy, adenoidectomy, postoperative hemorrhage, bleeding episode.

**Level of Evidence:** 2c.

*Laryngoscope*, 121:2553–2560, 2011

## INTRODUCTION

Tonsillectomy (TE), tonsillotomy (TO), and adenoidectomy (AE) are the most frequent surgeries in the field of otorhinolaryngology. The multicenter prospective Austrian Tonsil Study 2010 was set up to investigate all surgeries performed nationwide within 9 months, assessing operating characteristics and risk factors for the frequency and severity of postoperative hemorrhage. In the full survey, data from 9,621 patients of 32 ENT departments were entered prospectively into an online database recording about 100 variables for each patient. For the first time, not only the frequency of hemorrhage but also the severity of each bleeding episode was measured on a precisely defined scale of five severity grades, A through E (Table I).

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Editor's Note: This Manuscript was accepted for publication August 5, 2011.

The study was funded by the Austrian Society of Oto-Rhino-Laryngology, Head and Neck Surgery. The sponsor had no role in the study design, data collection, data analysis, data interpretation, and the writing of any publication related to the study. The authors have no other funding, financial relationships, or conflicts of interest to disclose.

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DOI: 10.1002/lary.22347

A variety of studies have dealt with postoperative hemorrhage as the most serious complication of tonsil surgeries. It is commonly accepted that bleeding episodes are classified into primary hemorrhage within the first 24 hours of surgery and secondary hemorrhage after the first 24 hours of surgery.<sup>1–6</sup> Furthermore, authors often differentiate between hemorrhage requiring surgical treatment and minor hemorrhage.<sup>4,7</sup> Because of varying definitions of what is considered a postoperative bleeding episode and differences in study designs, the reported hemorrhage rates and their risk factors vary considerably among studies.

In our study, we analyze both the frequency of postoperative hemorrhage (with the number of operated patients as a basis) and the severity of bleeding episodes (with the number of bleeding episodes as a basis). This double perspective allows us to take into account multiple bleeding episodes and to assess risk factors for TE, TO, and AE in an unprecedented way.

## MATERIALS AND METHODS

### *Study Organization and Patient Selection*

During a period of 9 months, from October 1, 2009, to June 30, 2010, a full survey was performed on all tonsillectomies (TE), adenotonsillectomies (TE+AE), tonsillotomies (TO), tonsillotomies with adenoidectomy (TO+AE), or merely

TABLE I.  
Classification of Postoperative Bleeding Episodes.

Day of bleeding episode	
T0	Day of surgery until midnight
T1	Midnight of day of surgery until next midnight (24 hr)
T2	Second day after surgery from midnight to midnight
T3	Third day after surgery from midnight to midnight
Tx	Analogue
T21	21st day after surgery from midnight to midnight
Severity of bleeding episode	
A	Anamnestically recorded blood-tinged sputum
A1	Wound is and stays dry, no coagulum upon inspection
A2	Coagulum upon inspection, dry wound after removal
B	Bleeding actively under examination, treatment necessary, dry wound afterwards, blood count in normal range, no shock
B1	Minimal hemorrhage, stops after noninvasive treatment (e.g., adrenalin sponge)
B2	Hemorrhage requiring treatment in local anesthesia
C	Surgical treatment in general anesthesia, blood count still in normal range, no shock
D	Dramatic hemorrhage, hemoglobin decreased, blood transfusion required, difficult surgical treatment, intensive care may be necessary
E	Exitus due to hemorrhage or hemorrhage-related complications
Examples	
T1A2	Coagulum upon inspection without hemorrhage on the first postoperative day, dry wound after removal
T2A2 and T5C	Coagulum upon inspection without hemorrhage on the second postoperative day, dry wound after removal. Second postoperative hemorrhage on day 5 requiring surgical treatment in general anesthesia

adenoidectomy (AE) in Austria (population 8.4 million). All patients, both adults and children, were recruited from 32 ENT departments, covering urban and rural areas.

Each department was responsible for gaining patient consent and entering the data of each case into a central online database. Cases were identified only by date of birth and date of surgery to maintain anonymity. Each participating department was able to revise the data of their own cases and to update these if necessary. Submission of data was monitored by the study team, and hospitals were contacted if support seemed to be necessary. Each month, every department received a summary report of the data being submitted.

### Collected Data

For each case, about 100 variables were recorded. Data on patient characteristics, surgery type, indication for surgery, grade of surgeon, operation technique, and postoperative hemorrhage were collected. Excluded from the central database were nonconsenting patients and all patients who underwent surgery because of tonsil cancer or underwent tonsil biopsy. The follow-up period for monitoring postoperative hemorrhage lasted at least 1 month after surgery. Operated patients were asked to visit the hospital immediately if they noted any kind of postoperative bleeding, even when it was minimal.

Postoperative hemorrhage was defined as any bleeding episode after extubation, with the severity of bleeding episodes recorded according to a precise classification of postoperative hemorrhage (Table I). The hemorrhage grades have been grouped into the five grades A through E in ascending order of the severity of bleeding episodes: anamnestic recorded blood-tinged sputum (grade A = A1 and A2), active bleeding under examination (grade B = B1 and B2), and hemorrhage requiring a return to the operating room (grades C and D). As no single case of grade E (fatal bleeding) occurred, this category was not

considered further in this study. Grades A and B were counted as minor bleeding episodes, and grades C and D were counted as severe bleeding episodes.

Six options for the indication of surgery were defined: recurrent infections, enlargement of the tonsils, obstructive sleep apnea syndrome (OSAS), peritonsillar abscess operated immediately, peritonsillar abscess operated electively, or others. Multiple answers were allowed if required. For data analyses, indications were grouped appropriately.

Operation techniques for TE were categorized into cold steel dissection, bipolar scissors, bipolar forceps, coblation, laser, or others. Laser, Colorado needle, or operation techniques other than those listed were used only in a very few patients and were not taken into specific consideration for statistical analysis. Operation techniques for AE were categorized into adenoid curette by Beckmann with or without endoscopic control, adenotome by La Force, and coblation technique.

### Database and Data Analyses

Patients were excluded from analyses if essential data like age of the patient or type of surgery were missing. Of the 9,621 cases submitted to the central database, 9,405 could be included for further analyses. Dependencies of categorized data were analyzed using  $\chi^2$  independence tests for cross-tabulations. Deviations for proportions in subgroups were tested two-sided with tests for proportions. *P* values < .05 were considered significant, *P* < .01 highly significant, and *P* < .001 extremely significant. Multivariate logistic regression was done to explore potential risk factors related to postoperative hemorrhage. The study was approved by the Ethics Committee of the Medical University Graz, Austria (21-072 ex 09/10). Statistical analysis was performed using PASW 18.0 (SPSS, Inc., Chicago, IL). The members of the study team were not involved in the submission of the data.

TABLE II.  
Type of Surgery and Age Group Per Patient and Hemorrhage Grade.

	No. of Patients		No. of Bleeding Episodes			
	Total (%)	Hemorrhage (%)	Total (%)	A1+A2 (%)	B1+B2 (%)	C+D (%)
Total	9,405 (100.0)	747 (7.9)	953 (100)	491 (52)	189 (20)	273 (29)
Type of surgery						
TE ± AE	4,594 (48.8)	689 (15.0)	889 (100)	457 (51)	183 (21)	249 (28)
TO ± AE	1,319 (14.0)	30 (2.3)	35 (100)	22 (63)	1 (3)	12 (34)
AE	3,492 (37.1)	28 (0.8)	29 (100)	12 (41)	5 (17)	12 (41)
Age group, yr						
<6	3,474 (36.9)	50 (1.4)	54 (100)	34 (63)	4 (7)	16 (30)
6–15	2,424 (25.8)	129 (5.3)	160 (100)	83 (52)	17 (11)	60 (38)
>15	3,507 (37.3)	568 (16.2)	739 (100)	374 (51)	168 (23)	197 (27)

TE = tonsillectomy; AE = adenoidectomy; TO = tonsillotomy; ± = with or without.

## RESULTS

### Characteristics of Patients and Operations

Of the 9,405 included patients, 58.2% were males. The entire study cohort was composed of 36.9% children aged less than 6 years and 37.3% adults older than 15 years. Among the surgery types, 48.8% were TE procedures; about half of them were accompanied by AE. The second most frequent surgery type was AE without removal of the tonsils, followed by TO, which was almost solely performed in combination with AE. For TE, the most common indication was recurrent tonsillitis, and the most frequently used operation technique was cold steel dissection.

### Frequency of Hemorrhage: Overview

The frequency of hemorrhage differed massively for different types of surgery and significantly for different age groups. TE ± AE showed with 15.0% by far the highest hemorrhage rate of all surgery types, compared to 2.3% for TO ± AE and 0.8% for AE (Table II). Adults were at a three times higher risk (568 of 3,707 [16.2%]) of postoperative hemorrhage than school children (129 of 2,424 [5.3%]).

### Severity of Bleeding Episodes: Overview

More than one half of all bleeding episodes (52%) were of grade A with just anamnestic records, whereas 29% of bleeding episodes were severe and treated with use of general anesthesia.

Surgery type seems to have an influence on the distribution of the severity of bleeding episodes, being on the edge of statistical significance ( $P = .059$ ). We found an increased relative risk of more severe bleeding episodes after AE (41% of all bleeding episodes after AE were severe) in comparison with TE (28%) or TO (34%).

Strong evidence was established for an age-related effect on the severity of postoperative hemorrhage ( $P = .007$ ). School children were at a remarkably elevated risk of severe hemorrhage (38% of all bleeding episodes) in comparison with adults (27%) and children younger than 6 years (30%) (Table II).

### Frequency of Hemorrhage: TE

The incidence of hemorrhage was studied separately for TE ± AE because TE is the type of surgery with the highest risk of postoperative bleeding.

Patient age, grade of surgeon, and operation technique had a significant influence on the frequency of hemorrhage after TE (Table III). Adults had the highest hemorrhage risk ( $P < .001$ ). Surgeries performed by registrars in training showed a lower hemorrhage rate ( $P = .02$ ). Bipolar diathermy in combination with cold steel dissection carried a higher risk compared to cold steel alone ( $P < .05$ ). The use of just electrocautery for dissection (bipolar scissor and forceps) had no significantly higher risk of hemorrhage compared to cold steel dissection alone ( $P < .87$ ). Coblation had a higher hemorrhage rate than cold steel dissection ( $P < .04$ ).

By multivariate logistic regression analysis, the following significant risk factors for postoperative hemorrhage could be identified (Table IV): Children aged younger than 6 years were three times less likely and school children were two times less likely to experience postoperative hemorrhage. A 1.3-fold increased risk was observed for males. A one fourth lower hemorrhage rate was achieved for abscess TE compared to recurrent infection. Surgeries performed by registrars (in comparison to consultants) were less likely to be followed by postoperative hemorrhage. The operation technique “cold steel in combination with bipolar scissors/forceps” showed a 1.5-fold increased likelihood of hemorrhage compared with cold steel alone.

### Severity of Bleeding Episodes: TE

About every eighth patient had a minor bleeding episode (12.1%) after TE and every 20th patient had a severe bleeding episode (5.2%) (Table V).

Severity of post-TE hemorrhage depended significantly on patient age and sex and operation technique (Table VI). For children younger than 6 years, significantly more minor bleeding episodes were recorded ( $P < .04$ ). Males had a significantly higher rate of severe bleeding episodes ( $P = .021$ ). We found no significant

TABLE III.  
Tonsillectomy With or Without Adenoidectomy: Patient Characteristics and Postoperative Hemorrhage Rates.

	Total (%)	No. of Patients		P Value*	RR
		Without Hemorrhage (%)	With Hemorrhage (%)		
All consenting patients (TE ± AE)	4,594 (100.0)	3,905 (85.0)	689 (15.0)		
Age, yr					
<6	230 (5.0)	214 (93.0)	16 (7.0)	<.001	1.0
6–15	1,073 (23.4)	961 (89.6)	112 (10.4)	<.001	1.49
>15	3,291 (71.6)	2,730 (83.0)	561 (17.0)	<.001	2.4
Sex					
Female	2,210 (48.9)	1,911 (86.5)	299 (13.5)	.053	1.0
Male	2,384 (51.1)	1,994 (83.6)	390 (16.4)	.063	1.22
Indication for surgery					
RT (single answer)	3,367 (73.3)	2,868 (85.2)	499 (14.8)	.773	1.0
TH ± OSAS	151 (3.3)	130 (86.1)	21 (13.9)	.71	0.94
RT + OSAS ± TH	297 (6.5)	256 (86.2)	41 (13.8)	.565	0.93
Abscess (elective/immediate)	594 (12.9)	513 (86.4)	81 (13.6)	.353	0.92
Others	185 (4.0)				
Grade of surgeon					
Consultant	2,448 (53.3)	2,069 (84.5)	379 (15.5)	.502	1.0
Specialist registrar	1,994 (43.4)	1,733 (86.9)	261 (13.1)	.017	0.85
Not specified	152 (3.3)				
Operation technique					
CS	4,012 (87.3)	3,450 (86.0)	562 (14.0)	†	1.0
CS + bipolar forceps or scissors	237 (5.2)	193 (81.4)	44 (18.6)	.05	1.33
Bipolar forceps/scissors (no CS)	133 (2.9)	115 (86.5)	18 (13.5)	.877	0.96
Coblation	55 (1.2)	42 (76.4)	13 (23.6)	.042	1.69
Others	157 (3.4)				

\*Total number as the baseline category.

†Cold steel as the baseline category.

RR = relative risk; TE = tonsillectomy; AE = adenoidectomy; RT = recurrent tonsillitis; TH = tonsillar hypertrophy; OSAS = obstructive sleep apnea syndrome; CS = cold steel; ± = with or without.

difference of hemorrhage risk between various indications for surgery ( $P = .99$ ). However, bleeding episodes of dramatic severity (grade D) occurred almost solely after TE owing to recurrent tonsillitis. The qualification of the surgeon had no significant effect on the bleeding severity. Surgery methods using bipolar diathermy had an elevated risk of severe bleeding episodes in comparison to cold steel dissection ( $P = .005$ ). Coblation showed a significant tendency toward more severe bleeding episodes ( $P = .031$ ). Patients operated with cold steel dissection alone experienced significantly less severe bleedings than patients operated with any technique other than cold steel alone ( $P = .01$ ).

### Multiple Bleeding Episodes After TE

Multiple bleeding episodes were recorded for one in 30 patients (3.3%), which is nearly one in four patients with hemorrhage (21.9%) (Table V). This table indicates that multiple bleeding is of considerable relevance when studying postoperative hemorrhage after TE. The sequence of severity for multiple bleeding episodes is of special interest. We assume that the occurrence of light bleeding is an indicator for a second severe bleeding epi-

sode. Testing this question, we found that one in 10 patients who experienced postoperative minor bleeding had a second severe bleeding (54 of 532 [10.2%]). Comparing this with the overall risk of severe bleeding after TE of 5.2% (239 of 4,594) yields an extremely significant result ( $P < .001$ ). This allows the conclusion that the evidence of minor bleeding (even only of anamnestic nature) increases the risk of a second severe bleeding episode by the factor two above the overall risk of a severe bleeding (5.2% → 10.2%). Almost half of the second severe bleeding episodes occurred on the day after the light bleeding episode (41%).

### Frequency of Hemorrhage: AE

The hemorrhage rate for AE was very low at 0.8% and did not differ statistically significant for the operation methods used ( $P = .76$ ). The adenoid curette by Beckmann with or without vision control was used in 73.1%, showing a hemorrhage rate of 0.6%. The adenotome by La Force applied in 3.4% had a slightly elevated hemorrhage rate of 0.9%. Coblation technique was used less frequently in 1.7% of all adenoidectomies with postoperative bleeding episodes reported in 1.1%.

TABLE IV.  
Tonsillectomy With or Without Adenoidectomy: Multivariate Logistic Regression Model for Postoperative Hemorrhage.

Risk Factor	Adjusted Odds Ratio	95% Confidence Interval	P Value
Age (yr)			
>15	1.0		
6-15	0.54	0.43-0.67	<.001
<6	0.32	0.19-0.54	<.001
Sex			
Female	1.0		
Male	1.32	1.12-1.56	.001
Indication for surgery			
RT (single answer)	1.0		
TH ± OSAS	0.85	0.52-1.38	.51
RT + OSAS ± TH	1.08	0.76-1.54	.67
Abscess (elective/immediate)	0.75	0.58-0.97	.03
Others	0.99	0.65-1.53	.99
Grade of surgeon			
Consultant	1.0		
Specialist registrar	0.82	0.68-0.97	.022
Operation technique			
CS	1.0		
CS + bipolar forceps/scissors	1.44	1.022-2.04	.037
Bipolar forceps/scissors	0.88	0.53-1.46	.615
Coblation	1.63	0.86-3.08	.137
Others	2.39	1.54-3.72	<.001

RT = recurrent tonsillitis; TH = tonsillar hypertrophy; OSAS = obstructive sleep apnea syndrome; CS = cold steel; ± = with or without.

## DISCUSSION

This nationwide, multicenter, prospective study evaluated hemorrhage rates after TE, TO, and AE for two outcomes: the frequency and the severity of bleeding episodes. Both the frequency and severity of postoperative hemorrhage varied extremely significant for different surgery types and age groups. Although more

than half of all surgeries were AE and TO, only 5% of all bleeding episodes were recorded for these types. For TE, the risk factors patient age, patient sex, indication for surgery, grade of surgeon, and operation techniques influenced both the frequency and severity of hemorrhage significantly. Patients with a minor postoperative bleeding episode showed a dramatically higher risk of a second severe bleeding episode. For this reason, monitoring of minor postoperative bleedings is helpful for anticipating severe bleeding episodes.

### Hemorrhage Rate After TE

The topic of post-TE hemorrhage is covered well in the literature, and differing hemorrhage rates have been reported. Blakley analyzed 63 reports on post-TE hemorrhage and described a mean hemorrhage rate of 4.5% with a standard deviation of 9.4%. He suggested a maximum expected hemorrhage rate of 13.9%.<sup>8</sup> The largest study on post-TE hemorrhage was the prospective National Tonsil Audit in the United Kingdom by Lowe et al. in 2007 with about 34,000 patients undergoing TE.<sup>9</sup> They reported a postoperative hemorrhage rate of 3.5% when considering bleeding episodes occurring during hospital stay and bleedings leading to readmission; 0.9% of all patients were returned to the operating room. Using data from the same study, Lowe and van der Meulen found that postoperative hemorrhage after TE with bipolar methods or coblation is three times higher compared to cold steel TE alone.<sup>7</sup> A retrospective study by Windfuhr et al. conducted on 15,218 patients in Germany in 2005 states a rate of return to the operating room of 2.86% for TE and 0.25% for AE.<sup>2</sup> A meta-analysis of Krishna and Lee reported a hemorrhage rate of 3.3% after TE for patients with normal coagulation tests.<sup>10</sup> A recent prospective multicenter study published by Tomkinson et al. in 2011 evaluating about 17,500 tonsillectomies with or without AE in Wales found a “primary minor hemorrhage” of 0.1% (within the first 24 hours after surgery, no return to operating room), a “secondary minor hemorrhage” of 1.8% (after 24 hours of surgery, readmission to hospital, no return to operating

TABLE V.  
Patients With Multiple Bleeding Episodes After Tonsillectomy (With or Without Adenoidectomy).

	No. of Cases	% of All Patients, n = 4,594	% of Patients With Hemorrhage, n = 689	% of First Bleeding is Minor, n = 532	% of Severe Bleeding, n=239	% of Multiple Hemorrhage, n = 156
All patients	4,594	100.0				
Patients with hemorrhage*	689	15.0	100.0			
Minor bleeding(s) (grades A+B)*	556	12.1	80.7			
First bleeding is minor*	532	11.6	77.2	100.0		
Only minor bleeding(s)*	478	10.4	69.4	89.8		
Severe bleeding(s)* (grades C+D)	239	5.2	34.7	NA	100.0	
Only severe bleeding(s)*	161	3.5	23.4	NA	67.4	
Patients with multiple bleedings	151	3.3	21.9	NA	NA	100.0
Severe bleeding after minor bleeding	54	1.2	7.8	10.2	22.6	35.8
Minor bleeding after severe bleeding	24	0.5	3.5	NA	10.0	15.9

\*Single and multiple bleeding(s).  
NA = not applicable.

TABLE VI.  
Tonsillectomy With or Without Adenoidectomy: Patient Characteristics for All Hemorrhage Grades.

	Total (%)	A1 (%)	A2 (%)	B1 (%)	B2 (%)	C (%)	D (%)
Total no. of bleeding episodes	889 (100)	157 (18)	300 (34)	112 (13)	71 (8)	241 (27)	8 (1)
Age, yr							
<6	19 (100)	9 (47)	5 (26)	2 (11)	0 (0)	3 (16)	0 (0)
6–15	138 (100)	20 (14)	51 (37)	13 (9)	0 (0)	52 (38)	2 (1)
>15	732 (100)	128 (17)	244 (33)	97 (13)	71 (10)	186 (25)	6 (1)
Sex							
Female	368 (100)	75 (20)	134 (36)	34 (9)	30 (8)	89 (24)	6 (2)
Male	521 (100)	82 (15)	166 (32)	78 (15)	41 (8)	152 (29)	2 (1)
Indication for surgery							
RT (single answer)	642 (100)	115 (18)	217 (34)	84 (13)	49 (8)	171 (27)	6 (1)
TH ± OSAS	28 (100)	1 (4)	13 (46)	2 (7)	5 (18)	7 (25)	0 (0)
RT + OSAS ± TH	54 (100)	10 (19)	19 (35)	8 (15)	3 (6)	13 (24)	1 (2)
Abscess (elective/immediate)	108 (100)	18 (17)	34 (31)	13 (12)	11 (10)	32 (30)	0 (0)
Others	57 (100)	13 (23)	17 (30)	5 (9)	3 (5)	18 (32)	1 (2)
Grade of surgeon							
Consultant	484 (100)	69 (14)	179 (37)	57 (12)	45 (9)	130 (27)	4 (1)
Specialist registrar	341 (100)	70 (21)	101 (30)	50 (15)	22 (6)	94 (28)	4 (1)
Not specified	64 (100)	18 (28)	20 (31)	5 (8)	4 (6)	17 (27)	0 (0)
Operation technique							
Cold steel (CS)	717 (100)	124 (17)	239 (33)	97 (14)	63 (9)	186 (26)	8 (1)
CS + bipolar forceps/scissors	61 (100)	11 (18)	21 (34)	4 (7)	1 (2)	24 (39)	0 (0)
Bipolar forceps/scissors	27 (100)	8 (30)	9 (33)	1 (4)	1 (4)	8 (30)	0 (0)
Coblation	16 (100)	1 (6)	9 (56)	3 (19)	0 (0)	3 (19)	0 (0)
Others	68 (100)	13 (19)	22 (32)	7 (10)	6 (9)	20 (29)	0 (0)

RT = recurrent tonsillitis; TH = tonsillar hypertrophy; OSAS = obstructive sleep apnea syndrome; CS = cold steel.

room), and a rate of return to operating room of 1.5%. The authors admitted that minor bleedings were recorded poorly in their multicenter observational study.<sup>4</sup> Attner et al. reported in 2009 a hemorrhage rate of 7.5% in a prospective study covering 2,800 cases.<sup>5</sup>

In our study, the post-TE hemorrhage rate is 15.0% (including all severity levels), and 4.6% of all patients had to return to the operating room. These values are considerably higher than in other studies and require some considerations. One reason is the very strict definition of hemorrhage, which includes also anamnesticly recorded hemorrhage. A second argument is that the primary goal of our study was to investigate postoperative hemorrhage, and thus any bleeding episode was in the focus of all participating surgeons. Moreover, in Austria, almost all tonsillectomies are performed as an inpatient procedure with an average hospital stay of about 3 nights after surgery, which allows us to cover all bleeding episodes happening within the first postoperative days. Another factor to take into consideration when comparing hemorrhage rates is the age structure of patients. A final argument for finding elevated hemorrhage rates in our study is the high awareness of this subject in the Austrian ENT community. Risks of postoperative hemorrhage have been discussed for years in Austria because of several fatal postoperative bleeding episodes in young children, which alerted the public.

### Risk Factors for Post-TE Hemorrhage

We analyzed the risk factors for post-TE hemorrhage along two different statistical methods: testing hemorrhage rates of a specific subgroup against the whole population (using a test for proportions) (Table III) and a logistic regression model, which takes all risk factors into consideration simultaneously (Table IV). Although the plain testing of hemorrhage proportions for specific subgroups yielded a number of significant results, the simultaneous coverage of all influencing factors via logistic regression offers a much sharper picture. In the literature, only a few authors used logistic regression for assessing hemorrhage risk.<sup>4,7,9</sup>

Results concerning risk factors for postoperative hemorrhage are controversially discussed in other studies.<sup>2–4,7,9,11</sup> The age of patients has consistently been described as a major risk factor for the occurrence of hemorrhage, with older patients being at higher risk.<sup>2–4,9</sup> Our study supports this finding. Moreover, our study also indicates that severe bleeding episodes are extremely rare for children younger than 6 years and that school children are more likely to experience severe bleeding episodes compared to the overall risk of severe bleeding.

In regard to sex, some authors have found a positive correlation for males being at higher risk of hemorrhage<sup>2,4</sup> and others have not.<sup>3,9</sup> We found that

bleeding episodes in males were more frequent and more severe. In the logistic regression model, the indication peritonsillar abscess for TE showed significantly lower hemorrhage rates than recurrent tonsillitis, confirming a similar result described by Lowe et al.<sup>9</sup> In our study the indication for surgery did not significantly affect the severity of post-TE bleeding episodes.

Registrars in training had a lower hemorrhage rate in our study. This might be justified, as consultants perform TE only in selected and more problematic cases, whereas registrars perform surgeries routinely.

Regarding operation techniques, our study confirms that bipolar techniques are associated with a higher postoperative hemorrhage risk as described in several other reports.<sup>6,7</sup> We observed that bipolar techniques tend toward more severe bleeding episodes but not toward higher hemorrhage rates in comparison to cold steel dissection. Coblation is also associated with higher hemorrhage rates, as described in the literature.<sup>12</sup>

### **Hemorrhage Rate After AE**

For AE, hemorrhage rates were very low: only 28 of 3,495 (0.8%) patients experienced bleeding postoperatively. Post-AE bleeding did not differ for the operation methods used (adenoid curette by Beckmann with or without endoscopic control, adenotome by La Force, coblation technique). For AE we found a tendency toward more severe bleeding episodes (41% of all bleeding episodes) in comparison to TE (28%) and TO (34%). This may be justified by the fact that for children, mild bleeding episodes may remain unnoticed because a child may easily swallow blood and no bleeding will be recognized.

### **Limitations**

Our study was intended as a complete survey of tonsil and adenoid surgeries performed in public hospitals in Austria for a period of 9 months. Because most surgeries were performed in public hospitals, the study covered at least 90% of all tonsil and adenoid surgeries performed in Austria within the study period. The collection of data worked very well owing to strict monitoring, regular feedback to the participating departments, and instant support in cases of problems. The database contained only a few missing values of minor importance, which did not seriously affect our investigations.

A methodologic bias of our study lies in the fact that the severity of bleeding episodes was measured according to the medical treatment that was applied and not according to the actual intensity of bleeding episodes. Because young children were usually returned to the operating room even if bleeding episodes were just moderate, our study reports for that age group an extremely low rate of grade B bleeding episodes and a considerably higher rate of grade C bleeding episodes compared to the adult age group (Table VI).

### **CONCLUSION**

The findings of our study indicate that the intensity of bleeding episodes is a crucial aspect of the investiga-

tion of postoperative hemorrhage, which has not been adequately addressed in the literature so far. By assessing differing grades of hemorrhage, this study offers an explanation for the variety of hemorrhage rates being reported in the literature. Our study shows that a classification of the severity of postoperative bleeding along objective medical criteria (Table I) is very useful. In the literature, postoperative hemorrhage is inconsistently measured, which leads to a wide variety of hemorrhage rates. Here we discuss a number of reasons for these inconsistencies. It is very important to discern between the frequency of hemorrhage (per patient) and the severity of each bleeding episode. Investigating the severity allows us to assess differing severity grades and to focus on multiple bleeding episodes. Assessing the severity (instead of the frequency of hemorrhage) shifts the basis of all rates from the number of operated patients to the number of bleeding episodes, making direct comparisons between frequencies and severity counts problematic. A major result of assessing the severity of multiple bleeding episodes was that the occurrence of a minor bleeding episode doubles the risk of a second severe bleeding episode. Therefore, we suggest readmission to hospital for patients experiencing a postoperative minor bleeding episode for 1 night, as almost half of the second severe bleedings occurred the following day after the light bleeding episode (41%). Other mechanisms to decrease the risk of postoperative bleeding episodes are careful use of bipolar diathermy and physical rest.

### **Acknowledgments**

The authors of this study thank all contributors for their cooperation and diligence, which provided us with data of remarkable quality. The authors thank all heads of Austrians' ENT-departments: Univ. Prof. Dr. Wolfgang Gstöttner, Univ. Prof. Dr. Wolfgang Biegenzahn, Univ. Prof. Dr. Klaus Böheim, Univ. Doz. Dr. Monika Cartellieri, Univ. Prof. Dr. Hans Edmund Eckel, Univ. Prof. Dr. Wolfgang Elsässer, Univ. Prof. Dr. Peter Franz, Univ. Prof. Dr. Gerhard Friedrich, Univ. Prof. Dr. Werner Habicher, Univ. Prof. Dr. Floris Heger, OA Dr. Gerhard Herzog, Univ. Doz. Dr. Heribert Höfler, Univ. Prof. Dr. Heinz Jünger, Univ. Prof. Dr. Christoph Karas, Univ. Prof. Dr. Tilman Keck, Univ. Prof. Dr. Antonius Kierner, OA Dr. Hannes Kirschner, Univ. Prof. Dr. Josef Meindl, Univ. Prof. Dr. Antal Mink, Univ. Prof. Dr. Michael Moser, Univ. Doz. Dr. Csilla Neuchrist, OA Dr. Johannes Neumüller, Univ. Prof. Dr. Peter Ostertag, OA Dr. Robert Panholzer, Univ. Prof. Dr. Robert Pavelka, OA Dr. Richard Pauer, OA Dr. Hannes Picker, Univ. Prof. Dr. Gerd Rasp, Univ. Prof. Dr. Christoph Reisser, Univ. Prof. Dr. Ernst Richter, Univ. Prof. Dr. Herbert Riechelmann, Univ. Prof. Dr. Herwig Swoboda, Univ. Prof. Dr. Patrick Zorowka. The authors thank especially all hospital staff contributing surgery data to the study: Doris Aichinger, MD, Ulrich Amann, MD, Anna Aszmayr, MD, Birte Bender, MD, Elisabeth Blassnigg, MD, Christoph Brand, MD, Elisabeth Brand, MD, Otto Braumandl, MD, Martin Bruch, MD, Christoph Flux, MD, Margit Gombotz, MD, Matthias Grabner, MD, Stefan Hoier, MD, Franjo Juric, MD, Joachim Kronberger, MD, Thomas Kunst, MD, Christoph Matscheko, MD, Hermine Mayr,

MD, Magdalena Necek, MD, Johannes Neumüller, MD, Anita Neuwirth, MD, Robert Panholzer, MD, Richard Pauer, MD, Christof Pauli, MD, Hannes Picker, MD, Robert Pinnitsch, MD, Julia Rechenmacher, MD, Andreas Riedler, MD, Kyros Sabbas, MD, Michael Safar, MD, Claus Schleinzer, MD, Barbara Schubert, MD, Johannes Schwarzer, MD, Anahid Seraydarian, MD, Andreas Strobl, MD, Beatrix Thalhammer, MD, Sandra Waltenberger, MD, Anette Wenzel, MD, Martin Wernig, MD, Claudia Winter, MD, Thomas Wöllner, MD, Gabriella Zahratka, MD, and Michaela Zumtobel, MD.

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