International Journal of Otolaryngology Research

ISSN Print: 2664-6455
ISSN Online: 2664-6463
Impact Factor: RJIF 5.44
IJOR 2023; 5(2): 46-52
www.otolaryngologyjournal.in
Received: 17-06-2023
Accepted: 26-07-2023

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Assessment of risk factors for secondary post-tonsillectomy hemorrhage in children

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DOI: https://doi.org/10.33545/26646455.2023.v5.i2a.31

Abstract
Background: Tonsillectomy, with or without adenoidectomy, is well recognized as one of the most often done surgical procedures in the field of pediatrics. It is commonly recommended for many reasons, such as repeated episodes of adenotonsillitis, obstructive sleep apnea, and peritonsillar abscesses. The aim of this study was to evaluate and assess the significance of the possible risk factors for secondary post tonsillectomy haemorrhage in children.
Methods: This prospective study was carried out on 70 patients aged from 3 to18 years old, both sexes, presented with secondary post tonsillectomy haemorrhage. Complete otorhinolaryngological clinical examination to detect tonsillar bed infection (purulent exudate from tonsillar bed, fever, sore throat with bad odor of the mouth) and severity of hemorrhage which is either minimal hemorrhage stopped spontaneously are assessed to all patients.
Results: Young age (3-5 years), female sex, number of attacks/ year and postoperative hemoglobin (Hb) level, cold season, Hot techniques of tonsillectomy (unipolar tonsillectomy), and analgesic (ibuprofen) were significant predictors of secondary post tonsillectomy hemorrhage (PTH) requiring management either conservative or second surgical intervention whereas other parameters were insignificant predictors.
Conclusions: There are numerous risk factors associated with secondary post-tonsillectomy bleeding in children. Analgesic (ibuprofen) were significant predictors of secondary PTH requiring management either conservative or second surgical intervention whereas other parameters were insignificant predictors.

Keywords: Tonsillectomy, hemorrhage, PTH, ABO grouping, risk factors

Introduction
Tonsillectomy, with or without adenoidectomy, is well recognized as one of the most often done surgical procedures in paediatrics. It is recommended for several reasons, such as recurring episodes of adenotonsillitis, obstructive sleep apnea, and peritonsillar abscesses [1, 2].
Adenotonsillectomy often leads to several severe consequences, such as post tonsillectomy haemorrhage (PTH), pain, nausea, vomiting, and dehydration [3, 4].
Delayed (secondary) PTH which occurs more than 24 hours following surgery [5].
The incidence of subsequent bleeding, occurring more than 24 hours following surgery, ranges from 0.1 to 3.35 as reported in published literature. Secondary bleeding occurs when the crust detaches from the site where the tonsils were removed. The initial risk variables associated with post-tonsillectomy haemorrhage (PTH) include gender, age, rationale for tonsillectomy, operation method and device, and the surgeon's degree of skill. This bleeding complication consistently necessitates readmission for medical monitoring or surgery to manage the bleeding [6, 7].
Although efforts have been made to decrease the occurrence of post-tonsillectomy haemorrhage by implementing changes in surgical techniques and using advanced methods and materials to achieve optimal blood clotting, this complication still poses a significant risk to patients' health and even their lives. Unfortunately, there are currently no established guidelines for managing this issue [8, 9].

The objective of this research was to evaluate and assess the significance of the possible risk factors for secondary PTH in children.

Patients and Methods

This prospective study was carried out on 70 patients aged from 3 to18 years old, both sexes, presented with secondary post tonsillectomy haemorrhage.

The study was done from June 2022 to June 2023 after approval from the Ethical Committee Tanta University Hospitals, Tanta, Egypt. An informed written consent was obtained from relatives of the patients.

Exclusion criteria were patients with other types of PTH as primary PTH, patients who are presented with post adenoidectomy hemorrhage, upper gastrointestinal tract (GIT) or upper respiratory bleeding, which is considered as false PTH, patients underwent tonsillectomy as a part of palatoplasty for snoring and underwent unilateral tonsillectomy for biopsy to exclude malignancy.

A de-identified database was constructed including history taking

1. The variables collected for patient data included demographic information, body mass index (BMI), presence of comorbidities, syndromes, history of recurrent tonsillitis attacks (with symptoms such as sore throat, fever of 38.3 °C [101°F], swollen lymph nodes, tonsil discharge, or positive test for group A β-haemolytic streptococcus), preoperative haemoglobin level, preoperative use of anti-bleeding medications, coagulation profile, history of sleep breathing disorder/obstructive sleep apnea, history of bleeding disorders, and gastroesophageal reflux.
2. The information required includes the following: the surgery date, the discharge date after tonsillectomy, the surgeon's level of expertise (senior [registrar and above] or junior), whether a concurrent adenoidectomy tonsillectomy procedure was performed, the reason for the operation, the dissection technique used (monopolar, bipolar, or cold dissection), whether the physician documented any cases of secondary tonsillectomy bleeding, the date of bleeding, and the season in which the surgery took place. The season was classified into the cold season, which spanned from November to February, and the warm season, which extended from March to October.
3. This study examines the use of medication after tonsillectomy, specifically ibuprofen or other non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol, and antibiotics. It also investigates post-operative fever, the use of antibiotics and painkillers after surgery, the date of bleeding occurrence, and the methods used to manage bleeding, including conservative follow-up or surgical intervention such as cauterization or suturing. Other factors considered are the length of postoperative hospital stay, the incidence of bleeding, the haemoglobin (Hb) level, and the need for blood transfusion.

General examination

To detect any other co-morbidities, syndromes or degree of shock if present.

Complete otorhinolaryngological clinical examination

To detect tonsillar bed infection (purulent exudate from tonsillar bed, fever, sore throat with bad odor of the mouth) and severity of hemorrhage which is either minimal hemorrhage stopped spontaneously or hemorrhage requiring admission with conservative follow up or re-operation for hemostasis revision in the operating room under general anesthesia.

Statistical analysis

The statistical analysis was conducted using SPSS v26 software (IBM Inc., Chicago, IL, USA). The quantitative variables were represented by their mean and standard deviation (SD). Qualitative variables were shown in terms of frequency and percentage (%). Logistic regression is used to evaluate the association between a dependent variable and one or more independent variables. A two-tailed P value less than 0.05 was deemed to be statistically significant.

Results

Regarding demographic data, the mean age was 8.5 ± 4.45 years. There were 45 (64.29%) patients with a range of age of 3-5 years and 25 (35.71%) patients with a range of age of 6-18 years. There were 26 (37.14%) males and 44 (62.86%) females. Regarding ABO grouping, 32 (45.71%) patients were O^+, 21 (30%) patients were A^+, 9 (12.86%) patients were B^+, 4 (5.71%) patients were AB^+, 2 (2.86%) patients were O^-, 1 (1.43%) patient were A^-, 1 (1.43%) patient were B^- and none of the studied patients were AB^-. History of OSA was a risk factor in 46 (65.71%) patients, history of gastroesophageal reflux was a risk factor in 48 (68.57%) patients and history of any other comorbidities was a risk factor in 45 (64.29%) patients. Per year 3 (4.29%) patients had 1-4 tonsillitis attacks and 67 (95.71%) patients had 5-8 tonsillitis attacks. The indication for the operation was chronic tonsillitis in 68 (97.14%) patients and was other indications in 2 (2.86%) patients. Table 1.

Table 1: Demographic data, ABO grouping, risk factors of bleeding and tonsillitis attacks and indication of operation of the studied patients

		N=70
Age (years)		8.5 ± 4.45
3-5 years		45 (64.29%)
6-18 years		25 (35.71%)
Sex	Male	26 (37.14%)
	Female	44 (62.86%)
ABO		
O^+		32 (45.71%)
A^+		21 (30%)
B^+		9 (12.86%)
AB^+		4 (5.71%)
O^-		2 (2.86%)

A^-		1 (1.43%)
B^-		1 (1.43%)
AB^-		0 (0%)
Risk factors of bleeding		
History of OSA		46 (65.71%)
History of gastroesophageal reflux		48 (68.57%)
History of any other comorbidities		45 (64.29%)
Tonsillitis attacks and indication of operation		
Tonsillitis attacks per year	1-4	3 (4.29%)
	5-8	67 (95.71%)
Indication of operation	Chronic tonsillitis	68 (97.14%)
	Others	2 (2.86%)

Data are presented as mean ± SD or frequency (%). ABO: Blood group system, OSA: obstructive sleep apnea.

Regarding the preoperative laboratory investigations, the Hb level with a mean of 11.3 ± 0.76 g/dL. The PLT count with a mean of 337.4 ± 31.77 *109 cell/L. INR with a mean of 1.1 ± 0.09. Regarding the postoperative complications, fever occurred in 42 (60%) patients and infection with signs of (purulent exudate from tonsillar bed, fever, sore throat with bad odor of the mouth and increase TLC and + CRP) occurred in 35 (50%) patients. Table 2.

Table 2: Preoperative laboratory investigations and postoperative complications of the studied patient

	N=70
Preoperative laboratory investigations	
Hb (g/dL)	11.3 ± 0.76
PLT (*10^9 cell/L)	337.4 ± 31.77
INR	1.1 ± 0.09
Postoperative complications	
Fever	42 (60%)
Infection	35 (50%)

Data are presented as mean ± SD or frequency (%). Hb: hemoglobin, INR: international normalized ratio, PLT: platelets.

Warm season was a risk factor of bleeding in 31 (44.29%) whereas cold season was a risk factor in 39 (55.71%) patients. Regarding the operative technique, 33 (47.14%) patients underwent monopolar surgery, 25 (35.71%) patients underwent bipolar surgery, and 12 (17.14%) patients underwent cold dissection. Regarding the surgeon's experience level, the operation was done by a senior in 38 (54.29%) patients and was done by a junior in 32 (45.71%) patients.

Regarding medication related risk factors, 33 (47.14%) patients received combination of penicillins and 37 (52.86%) patients received cephalosporins. 48 (68.57%) patients received Ibuprofen and 22 (31.43%) patients received Paracetamol. Table 3.

Table 3: Intraoperative data and medication related risk factors of the studied patients

		N=70
Technique	Monopolar	33 (47.14%)
	Bipolar	25 (35.71%)
	Cold dissection	12 (17.14%)
Surgeon experience level	Senior	38 (54.29%)
	Junior	32 (45.71%)
Season	Warm	31 (44.29%)
	Cold	39 (55.71%)
Medication related risk factors		
Post-operative antibiotics	Combination of Penicillins	33 (47.14%)
	Cephalosporins	37 (52.86%)
Post-operative antibiotics	Ibuprofen	48 (68.57%)
	Paracetamol	22 (31.43%)

Data are presented as frequency (%).

After operation, the 1st attack of bleeding occurred on the 5th day in 2 (2.9%) patients, on the 6th day in 3 (4.3%) patients, on the 7th day in 15 (21.4%) patients, on the 8th day in 9 (12.9%) patients, on the 9th day in 5 (7.1%) patients, on the 10th day in 10 (14.3%) patients, on the 11th day in 6 (8.6%) patients, on the 12th day in 3 (4.3%) patients, on the 13^{th} day in 5 (7.1%) patients, on the 14^{th} day in 7 (10.0%) patients, and ≥ 14^{th} up to 21 days in 5 (7.1%) patients. Table 4.

Table 4: Date of the first attack of bleeding after the operation in the studied patients

	N=70
5^{th}	2 (2.9%)
6^{th}	3 (4.3%)

7th	15 (21.4%)
8th	9 (12.9%)
9th	5 (7.1%)
10th	10 (14.3%)
11th	6 (8.6%)
12th	3 (4.3%)
13th	5 (7.1%)
14th	7 (10.0%)
≥ 14th up to 21 days	5 (7.1%)

Data are presented as frequency (%).

Postoperative Hb level with a mean of 8.01 ± 1.58 g/dL. Among the studied patients, 49 (70%) patients required blood transfusion. Postoperative admission with a mean of 5.96 ± 0.82 days. Postoperative management of bleeding was performed through conservation in 43 (61.43%) patients and surgical intervention (including cauterization of the bleeding point under general anathesia and suturing of the bleeding bed for approximation of tonsillar pillars) in 27 (38.57%) patients. Table 5.

Table 5: Hb level on admission and blood transfusion and PTH Hospital stay and management of bleeding in the studied patients

		N=70
Hb (g/dL)		8.01 ± 1.58
Blood transfusion		49 (70%)
PTH re-admission and hospital stay		5.96 ± 0.82
Management	Conservation	43 (61.43%)
	Surgical intervention	27 (38.57%)

Data are presented as mean ± SD or frequency (%). Hb: hemoglobin, PTH: Post tonsillectomy hemorrhage.

On univariate logistic analysis, Regarding patient related risk factors, young age (3-5 years), female sex, number of attacks / year and postoperative Hb level, procedure related risk factors, cold season, hot techniques of tonsillectomy (unipolar tonsillectomy), medications related risk factors and analgesic (ibuprofen) were significant predictors of secondary PTH requiring management either conservative or second surgical intervention whereas other parameters were insignificant predictors. Table 6.

Table 6: Univariate logistic regression analysis for presiction of second surgical intervention

	Coefficient	**SE**	**Wald**	**OR**	**95% CI**	**P value**
Age (days)	-0.259	0.085	9.20	0.771	0.652- 0.912	0.002*
Gender	1.877	0.563	11.12	6.533	2.17 - 19.68	0.001*
Season	1.906	0.585	10.60	6.729	2.13 - 21.19	0.001*
Analgesic (ibuprofen)	2.408	0.686	12.32	11.11	2.90- 42.62	<0.001*
History of OSA	-0.069	0.519	0.018	0.933	0.338- 2.579	0.894
History of Gastroesophageal reflux	0.143	0.526	0.074	1.154	0.411- 3.24	0.786
Number of attacks/ years	3.147	0.705	19.92	23.273	5.84 - 92.69	<0.001*
Technique	1.228	0.329	0.479	1.256	0.659- 2.394	0.001*
Surgeon experience	-0.084	0.493	0.028	0.920	0.349- 2.42	0.866
Preoperative Hb	0.001	0.327	0.000	1.001	0.527-1.899	0.998
PLT	0.001	0.008	0.017	1.001	0.986- 1.016	0.896
INR	4.86	2.849	2.909	129.04	0.48- 4375.2	0.088
Postoperative Hb	0.703	0.204	11.83	2.020	1.353-3.01	0.001*
Postoperative fever	-0.550	0.501	1.206	0.577	0.216 -1.539	0.272
Postoperative infection	-0.859	0.504	2.902	0.423	0.158- 1.138	0.088

OR: odds ratio, *: statistically significant as P value<0.05, CI: confidence interval, OSA: obstructive sleep apnea, Hb: hemoglobin, PLT: platelets; INR: INR: international normalized ratio.

Discussion

Tonsillectomy is a widely performed surgical procedure. Tonsillectomy is recommended for patients with recurrent tonsillitis, obstructive sleep apnea, and recurrent peritonsillar abscess [10]. The most often acknowledged reasons for performing a tonsillectomy in children are recurring infections of the tonsils and bilateral enlargement of the tonsils causing sleep disturbances [11].

Post-tonsillectomy haemorrhage occurring during the first 24 hours after surgery is referred to as primary post-tonsillectomy haemorrhage. On the other hand, bleeding that occurs beyond 24 hours after discharge is known as secondary post-tonsillectomy haemorrhage [12].

Our study showed that regarding ABO grouping of the studied patients, 32 (45.71%) patients were O+, 21 (30%) patients were A+, 9 (12.86%) patients were B+, 4 (5.71%) patients were AB+, 2 (2.86%) patients were O-, 1 (1.43%) patient were A-, 1 (1.43%) patients were B- and none of the studied patients were AB-.In agreement with our result, Leonard *et al.* [13] quoted that O blood type is disproportionately over-represented in their cohort of secondary hemorrhage patients when compared with the general population.

In the current study, warm season was a risk factor of bleeding in 31 (44.29%) whereas cold season was a risk factor in 39 (55.71%) patients. The history of OSA was a risk factor in 46 (65.71%) patients, history of

gastroesophageal reflux was a risk factor in 48 (68.57%) patients and history of any other comorbidities was a risk factor in 45 (64.29%) patients. In a previous study by Aldrees *et al.* [14]. In the analysed sample, 96.5% of individuals had adenoidectomy, with 64.1% of these procedures being conducted during the warm season. Senior surgeons performed 78.7% of tonsillectomies. Post-tonsillectomy haemorrhage was seen in 5.3% of these tonsillectomies.

The current findings revealed a statistically significant association between obstructive sleep apnea and post-tonsillectomy bleeding in both the univariable (OR=2.396; 95%CI = 1.192-4.819; P = 0.014) and multivariable (OR=3.581; 95%, CI=1.454-8.820; P = 0.006) analyses (95). In the current study, per year, 3 (4.29%) patients had 1-4 tonsillitis attacks and 67 (95.71%) patients had 5-8 tonsillitis attacks. The indication for the operation was chronic tonsillitis in 68 (97.14%) patients and was other indications in 2 (2.86%) patients. Recurrent attacks were significant predictors for bleeding. Prior research has shown a substantial correlation between a history of recurring tonsillitis and an increased likelihood of post-tonsillectomy bleeding. The frequency of post-tonsillectomy bleeding is greater in situations where repeated infections have occurred [8, 15].

Collison and Mettler [16] found that there was no significant difference between the bleeders and non-bleeders with respect to surgical indication.

Myssiorek *et al.* [17] observed that, ninety-one percent of patients with delayed hemorrhage had a history of chronic tonsillitis.

Regarding the operative technique, 33 (47.14%) patients underwent monopolar surgery which is a risk factor, 25 (35.71%) patients underwent bipolar surgery, and 12 (17.14%) patients underwent cold dissection. Aldrees *et al.* [14] No significant correlation was found between the method used for tonsillectomy and the occurrence of post-tonsillectomy hemorrhage. The findings align with the results of Kwok *et al.*'s investigation [15], which demonstrated no substantial difference in bleeding between cold dissection and bipolar diathermy. Tonsillectomy.

In addition, the use of hot treatments, particularly unipolar diathermy, was shown to be linked to higher levels of postoperative discomfort [18]. On the other hand, advocates of the unipolar surgical process argue that it is a more efficient and expedient method in comparison to cold dissection. Sarny *et al.* [19] discovered that the use of diathermy or coblation techniques increased the likelihood of postoperative bleeding when compared to the traditional cold steel tonsillectomy approach.

Regarding the surgeon experience level, the operation was done by a senior in 38 (54.29%) patients and was done by a junior in 32 (45.71%) patients. Multiple authors have shown that the likelihood of bleeding after a tonsillectomy is influenced by the proficiency of the surgeon, with a higher risk of bleeding seen when the surgery is conducted by inexperienced practitioners [20, 21]. The study conducted by Aldrees *et al.* [14] found no correlation between the proficiency of the surgeon and the occurrence of post-tonsillectomy haemorrhage. This finding is consistent with prior research [15, 22].

Our findings showed that after operation, the 1st attack of bleeding occurred on the 5th day in 2 (2.9%) patients, on the 6th day in 3 (4.3%) patients, on the 7th day in 15 (21.4%) patients, on the 8th day in 9 (12.9%) patients, on the 9th day in 5 (7.1%) patients, on the 10th day in 10 (14.3%) patients, on the 11th day in 6 (8.6%) patients, on the 12th day in 3 (4.3%) patients, on the 13th day in 5 (7.1%) patients, on the 14th day in 7 (10.0%) patients, and ≥ 14th up to 21 days in 5 (7.1%) patients. Kim *et al.* [23]. It was shown that bleeding occurring between the 6th and 8th days after surgery accounted for 49.6% of all patients experiencing haemorrhage. Postoperative haemorrhage occurred in 24.2% of children on the 8th day and in 18.2% on the 11th day following the procedure. Achar *et al.* [24] found that the average and most often occurring value for secondary PTH occurred on the seventh day after the procedure.

Postoperative Hb level ranged from 4 - 10.5 g/dL with a mean of 8.01 ± 1.58 g/dL. Among the studied patients, 49 (70%) patients required blood transfusion.

The World Health Organization (WHO) defines anaemia as a reduction in haemoglobin levels below 13 g/dl for males and below 12 g/dl for women. Several observational studies have shown a link between preoperative anaemia and a higher incidence of postsurgical complications in individuals having surgery [25].

In the current study, Postoperative hospital stay (after tonsillectomy) ranged from 5-12 hrs. With a mean of 8.98 ± 2.2 hrs. Susaman *et al.* [26]. Indicated that 88.9% of the pediatric patients and 91.3% of the adult patients were released from the hospital within 24 hours after undergoing tonsillectomy and thereafter received outpatient care. After PTH, a significant proportion of paediatric patients (51.9%) and adult patients (69.6%) were admitted to the hospital for a duration exceeding 48 hours. PTH prolongs the duration of hospital stays and results in increased expenses. The findings of Aldrees *et al.* [14] study also revealed that the longer the duration before discharging post-surgery, the higher the odds were for post-tonsillectomy bleeding. In the univariable analysis, the odds of post-tonsillectomy bleeding in patients discharged after more than 7 days were found to be greater (OR= 9.591; 95% CI = 1.659-54.266; P = 0.011).

As regard to post-operative analgesics, in this study there was a significant difference between patients received NSAIDs and others received paracetamol. Patients who received NSAIDs were riskier (68% of the population study). Marret *et al.* [27] proposed that the use of these medications should be avoided after a tonsillectomy. In contrast, Krishna *et al.* [28] found that the administration of aspirin after tonsillectomy raised the likelihood of PTH. However, their meta-analysis revealed that the use of non-aspirin NSAIDs did not substantially elevate the risk of PTH. NSAIDs have the ability to prolong bleeding time, which in turn may raise the risk of postoperative haemorrhage. Nevertheless, in individuals with intact coagulation systems, bleeding time often stays within the range of normal values. The clinical implications of the heightened susceptibility to bleeding in tonsillectomy are inconclusive. While several writers have identified the danger as substantial, others have seen it to be insignificant [29]. Aldrees *et al.* [14] No correlation was found between the administration of medicine, such as ibuprofen, paracetamol, and antibiotics, and the occurrence of post-tonsillectomy haemorrhage. Nevertheless, concerns have arisen about the use of ibuprofen and other non-steroidal anti-inflammatory drugs (NSAIDs) in individuals who have had tonsillectomy. A recent meta-analysis revealed that the use of antibiotics did not decrease the occurrence of post-tonsillectomy hemorrhage. Furthermore, the administration of antibiotics

to patients undergoing tonsillectomy does not adhere to the prescribed guidelines for antibiotic consumption [30].

The limitations of our investigation include a limited sample size, a single site study with a small cohort, and the fact that it was done in just one location. Consequently, there is a possibility that instances of post-tonsillectomy bleeding may have been sent to other centers instead of being treated at the original surgical hospital.

Conclusions

There are numerous risk factors associated with secondary post-tonsillectomy bleeding in children. The factors evaluated in our study revealed that regarding patient related risk factors, young age (3-5 years), female gender, number of attacks/ year and postoperative Hb level, regarding procedure related risk factors, cold season, Hot techniques of tonsillectomy (unipolar tonsillectomy) and regarding medications related risk factors, analgesic (ibuprofen) were significant predictors of secondary PTH requiring management either conservative or second surgical intervention whereas other parameters were insignificant predictors.

Financial support and sponsorship: Nil.

Conflict of Interest: Nil.

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How to Cite This Article
Younes MRA, Aglan YI, Eldein Behiry ABS, Tomoum M, Elhamshary AS. Assessment of Risk Factors for Secondary Post-Tonsillectomy Hemorrhage in Children. International Journal of Otolaryngology Research 2023; 5(2): 46-52.