The Value of Routine Preoperative Testing in the Prediction of Operative Hemorrhage in Adenotonsillectomy

Galila Zaher · Khaled Al-Noury

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Abstract Medical records were reviewed to identify subjects who ranged in age from 1 to 18 years and who had undergone tonsillectomy with or without adenoidectomy. Data obtained included patient demographic information, relevant medical history, history of hemorrhage, family history of hemorrhagic disorders, and drug history. Laboratory data obtained included a baseline coagulation screening to determine prothrombin time, activated partial thromboplastin time, and platelet count. Values were classified as within normal limits or as abnormally prolonged according to the local laboratory reference values. The incidence of postoperative hemorrhage in healthy subjects was evaluated, and the correlation between having a medical history of hemorrhage and an abnormal coagulation screen was assessed. We found that the medical history of the patients studied had positive predictive value of 42.8%, and a negative predictive value of 99.1%. The preoperative coagulation screening had a positive predictive value of 50%, and a negative predictive value of 93.6%.

Keywords Children · Hemorrhage and complications

Introduction

Tonsillectomy with or without adenoidectomy is the most common elective surgery in children [1]. Hemorrhage, which is a severe complication associated with those procedures, has been reported to occur in 2–4% of patients [2–5]. The need for routine preoperative coagulation screening for all children undergoing elective tonsillectomy with or without adenoidectomy has been investigated by many clinicians [6–11]. At our institute, there has not been a standardized approach to assessing that issue, and the decision to perform those screenings is left to the discretion of each attending otolaryngologist.

Patients and Methods

The medical records of 770 healthy children admitted for tonsillectomy with or without adenoidectomy (and with a minimum of 1-month follow-up) between January 2003 and 2007 were reviewed. Medical records were reviewed to identify patients aged between 1 and 18 years who had undergone tonsillectomy with or without adenoidectomy via the dissection technique. Standard policy dictated that such patients undergo posttonsillectomy follow-up examinations 1 and 4 weeks after surgery was performed in an outpatient clinic. The data obtained included patient demographic information, relevant medical history, history of hemorrhage, family history of hemorrhagic disorders, and drug history. Laboratory data obtained included a baseline coagulation screening (prothrombin time, activated partial thromboplastin time, and platelet count). Prothrombin time/activated partial thromboplastin time values were classified as being within normal limits or abnormally prolonged according to local laboratory

G. Zaher
Departments of Hematology, King Abdulaziz University
Hospital, 80205, Jeddah 21589, Saudi Arabia

K. Al-Noury
Department of Otolaryngology, Head and Neck Surgery,
King Abdulaziz University Hospital, 80205, Jeddah 21589,
Saudi Arabia

K. Al-Noury (✉)
35135, Jeddah 21488, Saudi Arabia
e-mail: Kalnoury@kau.edu.sa

reference values. The hospital laboratory defined abnormal values as values within 2 standard deviations from the mean. Patients with a prolonged prothrombin time/activated partial thromboplastin time were evaluated, and a consultation with a hematologist was obtained.

The operative log, emergency department records, and outpatient clinic notes of each patient studied were reviewed to determine outcomes. Patients with intraoperative or postoperative hemorrhagic complications were identified. Interventions (reoperation or replacement therapy in the form of packed red blood cell transfusion, platelets, or fresh frozen plasma transfusion) for the control of hemorrhage were recorded.

Data were collected and analyzed with SPSS II software (Statistical Product and Service Solutions, version 10, SSPS Inc, Chicago, Illinois), and descriptive statistics such as the mean, the standard deviation, and the *Z* test were used to calculate the *P* value. Three patients with a documented inherited bleeding disorder were excluded from the study; they had been diagnosed by a hematologist as having hemophilia A, hemophilia B, or von Willebrand disease, respectively. Those patients, who were appropriately treated and received replacement therapy, experienced no postoperative hemorrhage.

Results

The medical charts of 770 patients were reviewed. The demographic data are shown in Table 1. Six hundred eleven patients (81.3%) were younger than 10 years, and 170 patients (18.7%) ranged in age from 10 to 18 years. The male-to-female ratio was 1:1.3. Of those subjects, 62.1% had

undergone adenotonsillectomy, 12.9% had undergone tonsillectomy, and 25.1% had undergone adenoidectomy. The medical history of 739 patients (96%) was reviewed to identify prior episodes of hemorrhage, and ten patients (1.3%) had a history of such bleeding. A complete blood count was performed in 94% of patients, and a coagulation screen (prothrombin time/activated partial thromboplastin time) was performed in 98 patients (12.7%). Three patients exhibited an abnormal prolongation of activated partial thromboplastin time, two had mild thrombocytopenia above $100 \times 10^9/l$, and none exhibited abnormal prothrombin time. In our hematology clinic, the three patients with prolonged activated partial thromboplastin time underwent repeat prothrombin time/partial thromboplastin time testing, the results of which were within the normal range. All patients were subsequently approved to undergo surgery with no additional preparation. One patient experienced postoperative hemorrhage.

Postoperative hemorrhage was documented in nine patients (1.2%). One [of those nine patients] had an immediate postoperative hemorrhage that required reoperation, and the remaining patients required fresh frozen plasma, packed red blood cells, or a platelet concentrate transfusion to control the hemorrhage. Ten patients (1.4%) had a preoperative medical history of bleeding, and nine (90%) of those ten patients experienced postoperative bleeding. Ninety-eight patients had undergone preoperative coagulation screening, and although none had an abnormal prothrombin time result, three (3.1%) had a prolonged activated partial thromboplastin time and one (33.3%) [of those three patients] experienced postoperative bleeding. Two (0.3%) of the 732 patients who had undergone a preoperative complete blood count exhibited mild thrombocytopenia, but neither experienced bleeding as a complication (Table 2).

In our study, the sensitivity of the subjects' medical history was 33.3%, the specificity was 99%, the positive predictive value was 42.8%, and the negative predictive value was 99.1%. The preoperative coagulation screen had a sensitivity of 16.6%, a specificity of 97.8%, a positive predictive value of 50%, and a negative predictive value of 93.6%. The *P* value for the negative predictive value was calculated with the *Z* test ($P < 0.002$) (Table 3).

Patients with postoperative bleeding required hematology evaluation. Three patients were diagnosed as having an inherited bleeding disorder. The first of those patients had a medical history of hemorrhage and normal prothrombin time/activated partial thromboplastin time values, and his postoperative assessment suggested a diagnosis of Glanzmann's thrombasthenia. The second patient had a negative personal and family medical history of hemorrhage, but he exhibited a slight prolongation of the activated partial thromboplastin time, which was within normal limits on repeat testing. That patient was diagnosed

Table 1 Characteristics of the study subjects

	Frequency of bleeding	Bleeding (%)
Sex		
Male	432	56.1
Female	338	43.9
Type of operation		
Tonsillectomy	99	12.9
Adenoidectomy	193	25.1
Blood group		
Both	478	62.1
O	192	24.9
A	153	19.9
Rh D group		
AB	25	3.2
B	69	9.0
Positive	398	51.7
Negative	40	5.2

Table 2 Postoperative bleeding cross-tabulation in the study subjects

	Postoperative Hemorrhage		<i>P</i> value
	Bleeding (%)	No bleeding (%)	
Sex			
Male	55.6	56.1	0.973
Female	44.4	43.9	
PMH bleeding			
Positive	33.3	1.0	0.000
Negative	0.8	99.1	
APTT			
Abnormal	33.3	66.7	0.074
Normal	6.3	93.7	
Type of operation			
Tonsillectomy	22.2	12.7	0.507
Adenoidectomy	11.1	25.2	
Both	1.2	98.80	

Table 3 Sensitivity, specificity, negative predictive value, and positive predictive value of clinical history and coagulation tests

	History of hemorrhage (%)	Abnormal APTT (%)	<i>P</i> value
Sensitivity	33.3	16.6	
Specificity	99	97.8	
Positive predictive value	42.8	50	
Negative predictive value	99.1	93.6	<0.002

The *Z* test was used when appropriate

as having mild von Willebrand disease. The third patient had a medical history of hemorrhage, exhibited an activated partial thromboplastin time that was within normal limits, and was also diagnosed as having von Willebrand disease. One patient was lost to follow-up, and the other five patients were monitored and found to have no coagulopathic disorders. Neither of the two patients with mild thrombocytopenia exhibited postoperative bleeding (Table 4).

Table 4 Study subjects with postoperative bleeding

Sex	Age (year)	PMH	Preoperative APTT	Final diagnosis
Female	7	Negative	Abnormal	Von Willebrand's disease
Male	3	Positive	N	Lost to follow-up
Male	5	Negative	ND	Surgical bleeding, no coagulopathic condition
Male	2	Positive	N	Glanzmann's thrombasthenia
Female	5	Negative	Abnormal	Von Willebrand's disease
Male	6	Negative	ND	No coagulopathic condition
Male	3	Negative	ND	No coagulopathic condition
Female	2	Negative	ND	No coagulopathic condition
Female	6	Negative	ND	No coagulopathic condition

Discussion

The relatively lower threshold for blood loss in the pediatric population places children at higher risk for greater morbidity if the identification of a coagulopathic disorder is overlooked preoperatively. Severe hemorrhage after tonsillectomy or adenoidectomy can cause airway compression and even death [12, 13]. Immediate and primary posttonsillectomy hemorrhage are defined as hemorrhage within the first 24 h after the procedure; they are usually attributed to the reopening of small vessels in the surgical wound and are considered a more severe complication than later hemorrhage. Those types of hemorrhage occur when the patient's responsiveness and protective airway reflexes are blunted by narcotic effects. Delayed or secondary hemorrhage occurs more than 24 h after tonsillectomy (usually 5–10 days after surgery) [14]. Thus the preoperative identification of pediatric patients at risk for intraoperative or postoperative hemorrhage may result in a change in the management of those children.

To predict the outcome of hemorrhage, a detailed preoperative history is still the most sensitive tool. History taking should include prior instances of abnormal epistaxis, bruising, or hemorrhage after injury or previous surgery; medical conditions (such as liver disease, uremia, cancer, or malabsorption) that affect hemostasis; and a history of treatment with drugs that affect coagulation or inhibit platelet function. A family history of hemorrhage or confirmed coagulopathic conditions should be also reviewed. The results of a clinical history and physical examination are important elements in the preoperative evaluation for coagulopathic conditions [6]. However, in pediatric patients, the credibility of the clinical history may be low and has been shown to have certain limitations [15, 16].

Most children have lacked medical history or have not undergone a hemostatic challenge. It is quite difficult to assess the degree of abnormal hemorrhage after injuries based on parents history. Some of these children have a mild form of a hemorrhagic disorder that is not manifested until a hemostatic challenge, like that posed by surgery,

and occurs. It has been reported that up to 25% of inherited hemorrhagic defects may result from a spontaneous mutation or from the variable expression of a coagulopathic disease, in which case a family history is not helpful [17].

Approximately half of the patients with a previously undiagnosed coagulopathic disorder are diagnosed as having that type of disorder during or immediately after a surgical procedure [18, 19]. Ideally, to supplement history, the surgeon should perform a presurgical sensitive, specific, easily administered, inexpensive screening test for coagulopathic disorders. The most frequently used preoperative coagulation screening for patients undergoing tonsillectomy with or without adenoidectomy consists of determining the prothrombin time and the activated partial thromboplastin time. Some investigators have found such screening to be moderately useful in predicting which patients are at risk for hemorrhage [20–22], but others believe that screening is only warranted in patients with a positive medical history of hemorrhage [6–11].

It is important to remember that because the prothrombin time test reveals only extrinsic coagulation pathway defects, it is most often used to monitor patients treated with oral anticoagulation agents and to diagnose coagulopathic conditions that result from liver disease [23]. The ability of the prothrombin time test to detect inherited coagulation defects is minimal because most of those conditions are abnormalities of the intrinsic clotting system. However, the activated partial thromboplastin time test examines the intrinsic coagulation pathway and is therefore more suitable for the detection of an inherited disease (i.e. Factor VIII, VWF, IX, XI, or XII deficiency). However, because it is an *in vitro* assay, that test does not accurately reflect the haemostatic response *in vivo*. Furthermore, it is designed to confirm the clinical suspicion of a hemorrhagic disorder and is not to be used as a screening test in healthy populations in whom the prevalence of such disorders is low. In addition, activated partial thromboplastin time is not sensitive to mild inherited hemorrhagic disorders with factor levels of less than 30 IU/dl, such as hemophilia A or von Willebrand disease [23, 24]. Those test results are also affected by physiologic conditions (i.e. physical stress, trauma, pregnancy), which may also cause a false-negative result. Causes of false-positive results include the presence of lupus anticoagulant and factor XII deficiency.

Von Willebrand disease is probably the most commonly inherited coagulopathic disorder [25–27]. The true incidence of Von Willebrand disease is unknown because of the difficulty in diagnosing its milder forms and because of the lack of symptoms in most patients [20]. Von Willebrand disease is transmitted by an autosomal dominant gene with variable penetrance [28]. Fluctuations in the

Factor VWF level are influenced by the patient's blood group, pregnancy, stress, and hyperthyroidism. Therefore, patients with a mild form of von Willebrand disease may exhibit activated partial thromboplastin time and hemorrhage time that are within normal limits. Available screening tests are relatively insensitive, particularly in patients with no medical history of hemorrhage [19, 29].

Many previous studies have addressed the efficacy of preoperative screening for coagulopathic disorders in patients undergoing tonsillectomy with or without adenoidectomy (Table 5) [6, 14, 21, 22, 30, 31]. Some investigators recommend a thorough screening that will identify coagulation defects such as von Willebrand disease and hemophilia, because tonsillectomy with or without adenoidectomy is usually the first hematologic challenge in pediatric patients [7, 25, 29, 32, 33]. A few studies have advocated the routine use of a comprehensive coagulation test panel that identifies prothrombin, partial thromboplastin, and hemorrhage times; hemoglobin and hematocrit values; and the platelet count [17, 21, 22, 30, 32]. Others have questioned the efficacy of such preoperative screenings [6, 8, 9, 25, 29, 34, 35]. However, most of those studies were based on an adult population in whom clinical history may have a more reliable role and who many not need to undergo routine coagulation screening. Several studies of pediatric patients recommended the selective use of coagulation screening [6, 10, 11, 35, 36, 38]. In a study by Tami and colleagues [14], no difference was reported in the platelet count of patients who did or did not experience perioperative hemorrhage.

A baseline coagulation screening that includes prothrombin time, partial thromboplastin time, and platelet count does not measure platelet function. Measuring bleeding time is not a sensitive method, because it is not standardized in children and is not performed in our hospital. The platelet function analyzer (PFA 100), which is a relatively newer method for assessing platelet function, is a sensitive screening test for Von Willebrand disease and platelet dysfunction but is not used routinely in preoperative evaluations [39].

In 1999, the American Academy of Otolaryngology and Head and Neck Surgery recommended that coagulation screening tests in healthy children before tonsillectomy with or without adenoidectomy should be reserved for patients whose medical history or current physical examination indicates coagulation problems [40]. In lieu of the conflicting evidence, variable individual experiences, and the increasingly litigious legal climate, there has been an increase in the use of preoperative laboratory tests, despite those recommendations [41]. That trend has contributed to the dramatic increase in the overall cost of medicine. Toker and colleagues [42] reported that approximately 40–50% of otolaryngologists continue to

Table 5 Previous studies

Authors	Patients	Coagulation screen	Findings	Recommendations	Conclusions
Smith and colleagues [32]	250 children	PTT, PT, platelet count	Elevated mean PTT and hemorrhage time in the bleeding population	Routine PT, PTT, hemorrhage time	
Handler et al. [22]	1445 children	Hematocrit, PTT, PT, and hemorrhage time	No difference between bleeders and nonbleeders	Routine PT, PTT, hemorrhage time	
Manning et al. [6]	997 children	PTT, PT	Failed to predict and thus alter bleeding outcomes	Selective PT, PTT	17/27 patients with initial abnormal clotting values had no coagulopathic condition on further investigation
Burk et al. [9]	1603 children	PTT, PT, hemorrhage time	Large number of false-positive results; laboratory tests cause doubt about the value of screening	Routine screening because of the potential risk, albeit small, of the devastating outcome of posttonsillectomy hemorrhage	Only 43% remained abnormal on retesting
Kang et al. [7]	1061 children	PTT, PT, hemorrhage time, platelet count	Higher bleeding rate in patients with an initially abnormal coagulation profile	Routine PTT, hemorrhage time	
Zwack et al. [37]	4374 children	PTT, PT, hemorrhage time	Lower bleeding complication rate in the selectively screened group	PT, APTT, hemorrhage time in certain patients	
Gabreil [10]	1706 children	PT, PTT, hemorrhage time	Neither medical history nor laboratory tests predicted postoperative bleeding	Selective	Multicenter prospective study
Asaf [11]	416 children	PTT, PT	No correlation between normal and abnormal results	Selective	

determine the prothrombin time/activated partial thromboplastin time before tonsillectomy. The main reasons for performing preoperative coagulation tests included common practice (52%), defensive medicine (45%), hospital policy (16%), professional literature and experience (17%), and other reasons.

The 2008 British guidelines for the assessment of the risk of hemorrhage before surgery or invasive procedures state that routine coagulation testing to predict the risk of postoperative hemorrhage in unselected patients before surgery or other invasive procedures is not recommended (grade B, level III) [43]. That committee also pointed out that a structured approach to history taking should be used in all patients before surgery or invasive procedures (grade C, level IV).

The usefulness of preoperative hemoglobin and hematocrit determination in children has been evaluated, and the value of those tests has been questioned in several studies [44–47], the authors of which concluded that: (1) in healthy pediatric patients, the incidence of anemia is rare but is more likely to occur in those younger than 1 year of age, and (2) the deferral rate of surgery in anemic children aged 1 through 5 years is also rare; therefore, in that population such tests are traumatic, expensive, and unnecessary.

Our study revealed a general pattern in patients who were evaluated for [What, please?] preoperatively because there was no formal protocol for preoperative evaluation in place. The proportion of surgeons using the indiscriminate coagulation screen in our institute is lower than the rate reported by Toker and colleagues (13 vs. 40% to 50%, respectively) [42]. The incidence of postoperative hemorrhage in that study was 1.2%, which is similar to the incidence published in previous reports [2–5].

Routine coagulation screening revealed that only 1 patient in our study had hemorrhage due to blood dyscrasia, a finding not indicated in that individual's positive medical history of hemorrhagic disorders. In that patient, repeat testing revealed an activated partial thromboplastin time that was within normal limits. However, coagulation testing failed to identify Glanzmann's thrombasthenia in 1 patient and mild Von Willebrand disease in another. Fluctuations in the Factor VWF level could explain the normalization of activated partial thromboplastin time results in the patient who had no history of hemorrhage but did experience postoperative hemorrhage.

The hemorrhage rate was comparable in the selectively screened population and the routinely screened group (1%). This defies the purposes of routine screening, which are to identify patients with a bleeding tendency and to decrease the incidence of postoperative hemorrhage.

The value of a positive medical history of hemorrhage in the prediction of future episodes of hemorrhage has been evaluated by several investigators [8, 10, 25, 33]. With

respect to postoperative hemorrhage, the positive predictive value of hemorrhage history ranged from 0.02 to 0.23. Tosetto and colleagues [48] showed that although a poorly structured bleeding history does not predict postoperative hemorrhage, the use of a standardized questionnaire renders clinical assessment at least as effective as laboratory testing in predicting postoperative hemorrhage.

Conclusion

Although many pediatric patients who undergo elective tonsillectomy with or without adenoidectomy routinely receive some type of preoperative coagulation assessment, the use and predictive value of such evaluations have been debated. The incidence of posttonsillectomy hemorrhage in our study was 1.2%, which is similar to that published in the international literature. In predicting perioperative hemorrhage, both the clinical history and laboratory screening demonstrated high specificity but a very low positive predictive value due to poor sensitivity and the low prevalence of hemorrhage. Our results confirmed previous findings of the limitations of preoperative coagulation screening. Start we recommend using a structured approach to document bleeding history, completing a standardized questionnaire to improve positive predictive value, and reserving preoperative screening for patients with a history of a bleeding disorder and/or clinical examination results that are positive for bleeding.

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