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Bleeding after tonsillectomy

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Oropharyngeal hemorrhage after tonsillectomy is one of the most common postprocedural ENT emergencies that require immediate attention. Management choices depend on the severity of bleeding, underlying platelet or coagulation disorders, and the patient's maturity and age. Treatment range from simple observation to an emergent need to both secure the airway and stop the hemorrhage. The workup of the hemorrhagic patient will be discussed from the preoperative to postoperative time period. Surgical techniques in response to various acuity will be discussed to fully elucidate options to control the hemorrhage.
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Introduction

Epidemiology of tonsillectomy and tonsil bleeds

Tonsillectomy with or without adenoidectomy is one of the most common surgeries performed in the United States, especially for children, with rates exceeding half a million per year.[1] Posttonsillectomy hemorrhage or bleeding (PTB) remains a common source of phone calls and emergency center visits following tonsillectomy. A longitudinal study from the Pediatric Health Information System database involving 111,813 children from 2009-2013 suggest 2.8% rate of unplanned revisits for bleeding after tonsillectomy. Only 1.6% was readmitted from the emergency department and approximately 0.8% necessitated a procedure.[2] Significant variations do exist for revisits to the emergency department (range: 1.0%-8.8%).[3]

Contrary to anecdotal belief, PTB do not occur more frequently during the weekends than weekdays.[4] However, the frequency of bleeding is higher at night (71.2% vs 28.8%, $P = 0.002$). In fact, more than 50% of the bleeding occurs from a 6-total hour window between 10 PM-1 AM and 6-9 AM.[5] The reason for this is unclear but circadian rhythms may play a role in neuroendocrine and hemodynamic measures throughout the day. The vibratory effect of snoring and drier oral mucosa from chronic mouth breathing during sleep may also play a role. Furthermore, slight regional variation also exists in the United States with the lowest bleeding rate in the South at 2.5%, although the data did not incorporate all states in the country.[6]

The risk of bleeding in children with known coagulopathies may be as high as 53% although other estimates are lower with suggestions that the odds are twice as the normal population.[7,8] Hemophilia A and B as well as Factor VII deficiency are coagulopathies that are often the most dramatic in presentation but are rare. Meanwhile, von Willebrand disease is relatively common in the general population with a prevalence of up to 2%.[9] Patients may not always have an easy bruising or bleeding history. Tests for coagulopathies before tonsillectomies on children with no clinical suspicion for bleeding problems have low sensitivity, low bleeding predictive value, and are not routinely advised.[10,11] Therefore, sporadic cases are difficult to identify preoperatively if the patient has no previous history of easy bruising or bleeding.

Risk factors

Posttonsillectomy hemorrhage can rarely occur in the first 24 hours after tonsillectomy (primary PTB). Com-

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monly, it occurs more than 24 hours (usually 5-10 days) after tonsillectomy (secondary PTB).[12] Previous studies have identified older age as a possible risk factor for secondary PTB.[13-15] In a large database study of 35,085 tonsillectomies performed at hospital-owned ambulatory and inpatient facilities, male sex and increasing age were found to be independent risk factors for revisits related to bleeding.[12]

The inherent risk of PTB with stratification by surgical indication is controversial. Some authors have suggested tonsillectomies performed on children with sleep apnea may have a higher risk of bleeding than those performed on children with chronic tonsillitis.[16] The obstructive nature of sleep apnea has been theorized to increase the chance of bleeding by causing a stronger negative pressure gradient in the pharynx during the recovery period. A database study of over 138,998 procedures in California suggested older age and obesity as risk factors for PTB, but not sleep apnea.[17] Still others have found increased bleeding risk in those patients who have chronic tonsillitis.[14,15,18] Quinsy tonsillectomies has not been found to be associated with an increased hemorrhage rate.[19]

Intraoperative adjuncts such as peritonsillar injection of local anesthesia (with or without epinephrine) and painting of bismuth onto the tonsillar fossa has not found to be associated with a decrease chance of bleeding.[13] Neither were the use of perioperative antibiotics and ketorolac. Use of sucralfate postoperatively also was not associated with an increased chance of bleeding.[20] A recent Cochrane review suggested a nonsignificant increased odd of bleeding requiring surgical intervention with nonsteroidal anti-inflammatory drug use (odds ratio = 1.69, 95% CI: 0.71-4.01).[21] Similarly, the odds of bleeding requiring nonsurgical intervention was found to be odds ratio of 0.99 (95% CI: 0.41-2.40) suggesting little if any effect of nonsteroidal anti-inflammatory drug use of bleeding risk after tonsillectomy.

Operative technique has been one of controversy surrounding PTB rates. More recent developments of intracapsular tonsillectomy have favored the technique as causing less bleeding risk and pain. The trade-off comes from the risk of tonsillar regrowth and return of chronic tonsillitis or worsening of sleep apnea in the future.[22] Other studies have shown no difference in bleeding risk between electrocautery tonsillectomy and intracapsular tonsillectomy with a microdebrider.[23] Similarly, a study looking at blunt dissection vs bipolar electrocautery shows no difference in PTB rates.[24] Coblation vs electrocautery tonsillectomy has also been studied and the recent result of a meta-analysis suggests no difference in PTB rates.[25]

Vascular anatomy

The tonsils are mainly supplied by branches of the external carotid artery: lingual, facial, ascending pharyngeal, and internal maxillary arteries (in ascending order).[26] The ascending pharyngeal artery is a terminal branch artery (no other branching before supplying the tonsils). Meanwhile, the lingual artery supplies the tonsils via the tonsillar branch, the facial via the ascending palatal and tonsillar branch, and the internal maxillary via the descending palatal branch (Figure 1). The lingual artery itself has occasionally a contribution from the hyoid branch of the superior thyroid artery.[27] The superior thyroid, lingual, and facial arteries can also arise together from the external carotid as the thyrolingual or facial trunk.[28]

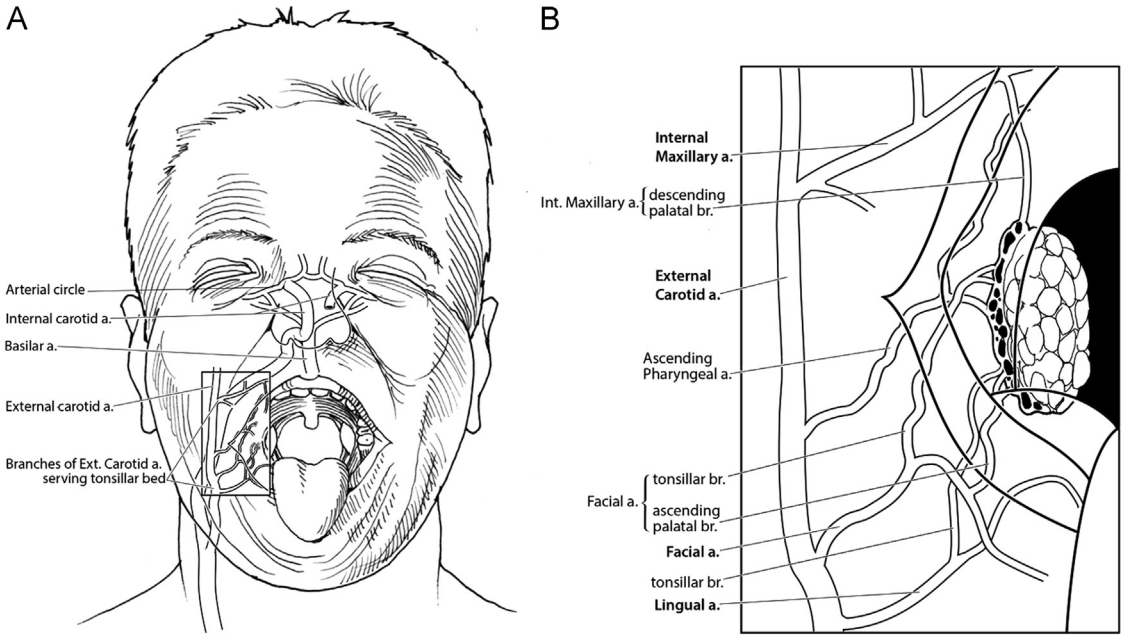

Figure 1 (A) Arterial branching patterns in the head and neck. (B) Branches of the external carotid artery supplying the tonsils and tonsillar fossa.

Occasional collateral anastomosis with the internal carotid system is possible. The ophthalmic artery (arising from the internal carotid) can anastomose with the internal maxillary artery via the middle meningeal artery and the facial artery via the infraorbital artery. Further connection with the vertebral artery system is possible via the occipital and cervical branches of the external carotid artery. Contralateral supply from the superior thyroid, lingual, facial, occipital, and temporal branches of the opposite carotid can also exist.[29] As the tonsils receive its blood supply from such a vast network of vessels, indiscriminate ligation of a major vessel may not be adequate to definitively stop bleeding.

Prevention approaches

Aside from proper operative technique and avoidance of thermal and mechanical injury to the peritonsillar fossa, very little has been found to be effective in preventing PTB.[30,31] Routine oversewing and closure of the tonsillar fossa does not prevent PTB.[32–34] A systematic review of 7 studies also failed to find a significant benefit from the use of fibrin glue hemostatic sealant in preventing PTB.[34] The use of Floseal has also been found to be ineffective in decreasing the risk of PTB but it has been shown to aid in mucosal recovery and to shorten the duration of pain-medication use.[35]

Similarly, systemic, antihemorrhagic agents have been proposed. Agents such as vitamin K and tranexamic acid's role in preventing PTB have not been fully studied but there appears to be little effect in PTB rates.[24] Tranexamic acid appears to decrease the volume of blood loss during PTB episodes but does not significantly reduce the risk of bleeding itself.[36]

Management approach

Evaluation of the PTB patient must be focused to answer important questions in the acute setting:

(1) Is the patient's airway secure?
(2) Is the patient hemodynamically compromised and need resuscitation?
(3) Does the patient need operative intervention to control bleeding or to prevent future bleeds?

Complete blood count as well as prothrombin time or international normalized ratio or partial thromboplastin time can help determine how much bleeding has occurred as well as the relevant platelet counts and the presence of any coagulation disorders. Prothrombin time or international normalized ratio or partial thromboplastin time may be normal in patients with von Willebrand factor (vWF) disease and platelet function assay (PFA-100) is the most sensitive screening test. Other tests including vWF antigen levels, ristocetin cofactor activity, factor VIII activity, and vWF multimer analysis can be used.[9]

Limited evidence exists for directing management in patients with coagulation disorders. Aminocaproic acid have been used in acute mucocutaneous bleeds in patients with von Willebrand disease. Its antifibrinolysis ability has been postulated to help in promoting coagulation in PTB. However, the medication appears to be more useful during acute episodes of hemorrhage rather than as a prevention. In a recent retrospective study on vWF patients matched to normal controls, use of aminocaproic acid did not decrease the likelihood of PTB.[37] However, desmopressin and oral aminocaproic acid may be enough alone to stop bleeding in some patients with vWD without surgery.[38]

Initial approaches

After presentation of postoperative bleeding, up to 50% of patient have no bleeding recurrence and can be managed conservatively.[13,39] Of those taken back to surgery for hemostasis, approximately 90% are successful in controlling hemorrhage (first attempt at surgical hemostasis). If bleeding recurs in subsequent episodes, the chances of success decreases to 50%-67% in a retrospective study for posttonsillectomy bleeds requiring surgical intervention in 209 patients.[39]

In a study of 181 patients with PTB, upon presentation, most patients have a positive oropharyngeal examination (65.3%). A positive examination includes presence of a clot (49.4%), ooze (21.5%), ooze and clot at the same time (6.3%), or active bleeding (18%).[40] The variability in practice patterns across physicians in their approach to each of the scenarios is unclear. It is conceivable that almost all physicians would take an actively bleeding patient back to the operating room for controlling hemorrhage. An oozing tonsillar fossa, especially in the presence of a clot is somewhat controversial and more conservative management such as transoral compression may be attempted although others may still take the child to the operating room. The presence of a clot alone prompts many physicians to ask the patient to gargle water to determine if bleeding would resume once the clot falls off. No studies were found specifically investigating this aspect of the decision tree for PTB.

Transoral compression of the bleeding area with clamped swab or index finger can control bleeding. One author suggests that this can be more effective that awaiting intubation and revision surgery as it stops the bleeding and protects the airway.[41] The patient does have to cooperate with this uncomfortable maneuver and feasibility is likely limited to older children and mature adults. Silver nitrate can be applied to the area of hemorrhage before application of pressure. The use of kaolin-impregnated gauze has recently been studied as a hemostatic agent during tonsillectomy and has shown some promise during tonsillectomy but its role in posttonsillectomy hemorrhage is not clear.[42] However, its use has been studied in trauma situations with external open wounds and is often sold and marketed as QuikClot Combat Gauze.[43]

Surgical control

As controlling hemorrhage can often be a high pressured, time sensitive procedure, proper preparation for the operat-

ing room is key. Increased hemorrhage at any point should be anticipated. Two suctions should be assembled and tested in preparation to evacuate blood. The McIvor and Crowe-Davis mouth retractors with the full spectrum of tongue blades should be in the room to ensure efficient placement of mouth retractions for exposure. The electrocautery machine should be tested with a suction cautery already assembled. Permanent suture, such as 4-0 silk, should also be available in the operating room should suture ligation be necessary.

During bleeding emergencies of the oropharynx, nothing by mouth times are largely irrelevant . Securing the airway takes precedence over the risk of aspiration. Furthermore, blood in the stomach is similar to having at least a full liquid diet. Induction for general anesthesia is accomplished largely by rapid sequence induction, most commonly with succinylcholine.[44] This allows rapid intubation of the child with minimal risk of vomiting and aspiration. Cricoid pressure is usually applied to decrease the risk of aspiration. In a retrospective cohort of 475 patients undergoing surgery for PTB, 2.7% (13 patients) were noted to have difficult intubation and none of these were difficult to intubation during the initial tonsillectomy. Most often the cause was blood in the upper airway and of the thirteen patients, 2 required more than one attempt at intubation. The use of a tracheostomy to secure the airway is exceedingly rare and not reported in large cases series in the literature.[44,45] Most patients can be resuscitated by infusion of crystalloid and rarely do patients need intraoperative red blood cell transfusions if bleeding is controlled.[44]

Surgical hemostasis can then proceed with full evaluation of the tonsillar fossa and recauterization or suture ligation of the offending site or vessel. Surgical hemostasis may require indiscriminate use of cautery because of several factors. The decrease in blood pressure due to bleeding or general anesthesia may temporarily stop bleeding, making identification of the bleeding source difficult. The offending vessel may also be retracted within the inflamed granulation tissue in the tonsillar fossa.[39]

In rare cases, vascular anomalies or pseudoaneurysms from the tonsillar, lingual, or internal carotid arteries can also be responsible for hemorrhage, although this is usually suspected during the initial tonsillectomy.[46-48] Transoral suture ligation can be attempted if the source of bleeding is easily found and access permissible to placement of permanent sutures over the injured vessels in a figure of eight. If the vessel is small, it can also be ligated with a permanent suture at both cut ends. The use of absorbable suture during repair has been implicated to cause delayed bleeding, as in the process of absorption, the suture can cause a fistulous connection from the vessel to the pharynx.[49] If bleeding persists, pressure should be applied and endovascular techniques can be attempted to embolize feeding vessels to the tonsillar fossa. As a last resort, in the face of hemodynamic instability and shock, ligation of the external carotid through an open neck incision can be performed.

Endovascular approach

Endovascular approaches usually involve cannulation of the right femoral artery using a 4 Fr catheter via percutaneous Seldinger technique (Figure 2). Bilateral angiography is performed first to search for anomalous vessel branching patterns and to identify abnormal connections between the external carotid and internal carotid systems, aneurysms, and arteriovenous malformations. A guide wire is then introduced into each of the vessels supplying the affected bleeding area: ascending palatine and tonsillar artery from the facial artery, then dorsal lingual artery from the lingual artery and descending palatine artery from the internal maxillary artery. Finally, the

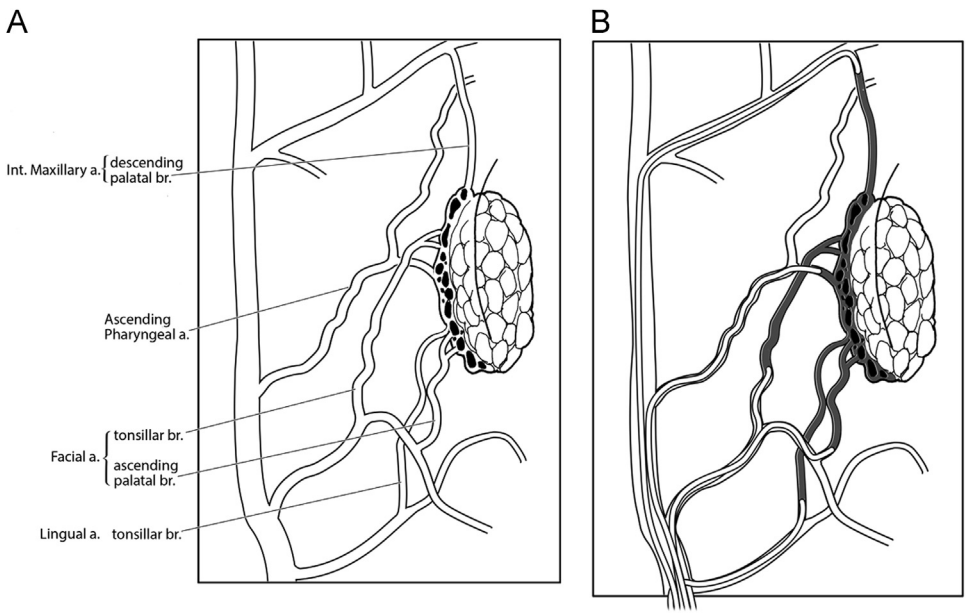

Figure 2 (A) Target vessels for embolization of the vessels supplying the tonsillar fossa. (B) A guide wire, followed by a 4 Fr catheter is introduced into each vessel supplying the affected bleeding area and the terminal vessels are embolized with polyvinyl alcohol particles.

superior tonsillar artery from the ascending pharyngeal artery is targeted and embolized with polyvinyl alcohol particles. Success of the embolization is tested by demonstrating signification reduction or termination of blood flow to the tonsillar fossa.[39] Use of endovascular technique compared to open surgery has a high success rate and is associated with a shorter hospital length of stay and lower need for red blood cell transfusions.[39] Use of endovascular technique have variable success in identifying the exact source of bleeding (0%-33%).[39,50]

Risks of the endovascular approach include unintended migration of embolization particles into the internal carotid or ophthalmic artery system. Use of coils are also possible but must be used at a more proximal location. Coil extrusion into the pharynx or surrounding head and neck region is also possible and carries a risk of infection. Perforation of the branch-vessel with extravasation of embolic material or contrast is also possible.[51] There is also a theoretical risk of occlusion at the femoral artery access site as systemic anticoagulation is usually not given owing to the nature of the acute hemorrhage. Nevertheless, the duration of the procedure is typically short (35 minutes) and risk minimal.[39]

Ligation of the external carotid

In dire situations, where bleeding cannot be controlled by surgical hemostasis (ie, electrocautery) or endovascular techniques and the patient is hemodynamically unstable, large vessel surgical ligation of the vascular supply to the tonsils may be necessary. Some authors even advocate for external carotid ligation if the patient has undergone 3 unsuccessful attempts at surgical hemostasis with concurrent low hemoglobin concentration.[39]

An incision is made along the supper 2/3 of the sternocleidomastoid muscle to expose the internal jugular and facial veins. The facial vein is then ligated to allow lateral and posterior retraction of the internal jugular vein. The carotid sheath should be identified and opened slightly below the level of the larynx. At this point, the vagus nerve should also be identified and protected (Figure 3). The external carotid artery can be differentiated from the internal carotid artery at this level by the presence of branches. The hypoglossal nerve should also be identified and protected near this location. Branches of the external carotid supplying the tonsillar fossa are individually ligated with a 0-silk suture.[52] If bleeding does not stop at this point, collaterals from the internal carotid system need to be identified. It is not advisable to ligate the common carotid artery due to risk of causing a stroke as well as the possibility of retrograde flow from the circle of Willis supplied by the vertebral artery.[53]

Conclusion

Posttonsillectomy hemorrhage remains a low, but potentially life-threatening risk after tonsillectomy. Approximately half of patients presenting to the emergency department with bleeding can be managed conservatively.

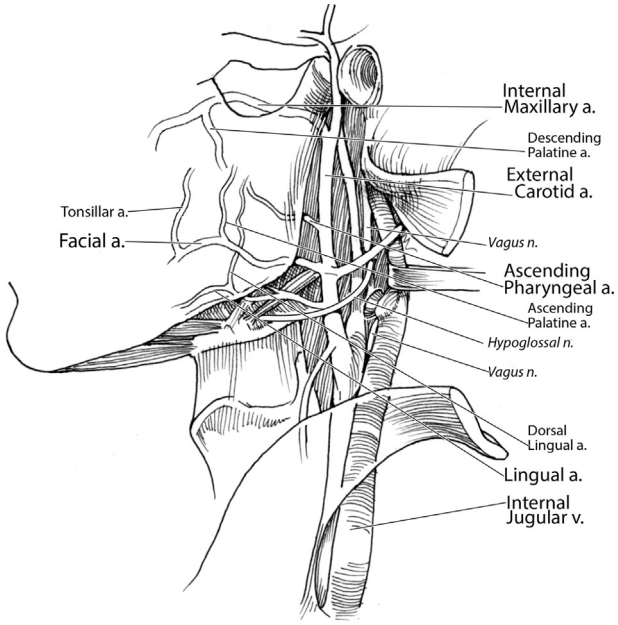

Figure 3 Neck exposure for the ligation of the external carotid artery. The vagus and hypoglossal nerves should be identified and protected. The external carotid artery can be differentiated from the internal carotid in the neck by the presence of branches. Vessels can be ligated with a 0-silk suture.

Aside from proper technique, very little proscriptive interventions have been found to be effective in preventing PTB. The remaining proportion of patients is managed with surgical cautery of the tonsillar fossa as mainstay therapy. Endovascular techniques with interventional radiology remain an option for patients where vascular malformations are suspected or for recalcitrant cases. Finally, ligation of the branches of the external carotid artery can be performed in life-threatening hemorrhage in hemodynamically unstable patients.

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