



Review Article

# Adenotonsillectomy in high risk patients: Hematologic abnormalities and COVID-19 considerations

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**Abstract** Adenotonsillectomy is one of the most common surgical procedures performed by otolaryngologists. It is vital that surgeons are aware of the risks in performing this surgery especially during the COVID-19 pandemic and in children with hematologic disorders. In this review we describe common hematologic disorders often noted in pediatric patients undergoing this procedure, as well as proper screening and management of these patients. In addition, we also address the impact of the COVID-19 pandemic and some measures to help mitigate the risks of this procedure during this time.

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## Introduction

Tonsillectomy and adenoidectomy (T&A) is one of the most common otolaryngology procedures performed in the United States, with upwards of 500,000 performed in children annually.<sup>1,2</sup> Although T&A is considered a routine procedure there are several risks and patient complexities to be considered.

Post-tonsillectomy hemorrhage (PTH) is a significant complication of T&A occurring in approximately 2–8%.<sup>3,4</sup> Patients with PTH frequently require another surgical procedure to obtain hemostasis, with severe bleeding some require embolization and rarely it is the cause of patient

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mortality. Along with the surgical implications, it causes significant distress and anxiety amongst both patients and their families. Therefore, one must consider outside factors that contribute to PTH. Patients with hematologic abnormalities are at increased risk while undergoing T&A, as they are more sensitive to changes in hemoglobin and are frequently unable to appropriately form clot. In addition, these hematologic abnormalities are often undiagnosed at the time of surgery, as children with underlying coagulopathies will frequently remain asymptomatic prior to a major bleeding event.

While patients with hematologic disorders have long been recognized as high-risk for T&A, an entirely new high-risk group has emerged in the past year due to the coronavirus disease 2019 (COVID-19) pandemic. Asymptomatic or pre-symptomatic COVID-19 patients could potentially transmit active sars-CoV-2 viral particles to the surgeon and other operating room staff during a T&A. This review will outline the pre-operative and intra-operative considerations for each of these high-risk populations and provide evidence to mitigate both patient and surgeon-related complications.

## Underlying coagulopathy

### Pre-operative considerations

T&A is typically the first major surgery in a child's life, therefore limited opportunity exists for children to develop a past history indicative of an underlying coagulopathy prior to surgery. Since PTH is the most feared and morbid complication of T&A, otolaryngologists have attempted to effectively identify patients with underlying coagulopathies for decades.<sup>5</sup> The incidence of both PTH and common underlying coagulopathies are rare, making it difficult to establish screening measures for pre-operative identification.

A survey evaluating pre-operative screening amongst otolaryngologists found up to 25% ordered at minimum a prothrombin time (PT) and partial thromboplastin time (PTT). In some cases a complete blood count (CBC) was also obtained.<sup>6</sup> While pre-operative laboratory testing still may be common in some areas of the country, there is more evidence to support that these tests offer limited predictive value to the surgeon. A meta-analysis by Krishna and colleagues demonstrated that PTH rates are equivalent in patients with abnormal PT/PTT vs those with normal PT/PTT, indicating that these pre-operative labs are of little value.<sup>7</sup>

Another method utilized for pre-operative screening is with a questionnaire, specifically for Von Willebrand Disease (VWD).<sup>8</sup> Similar to laboratory tests, they have good negative predictive value but poor positive predictive value.<sup>9</sup> The questionnaires are easily conducted without need for unnecessary blood draws making them more advantageous over pre-operative blood work.

More recent literature has also shown that screening for an occult coagulopathy after post-tonsillectomy hemorrhage is also low-yield and potentially unnecessary. Gitomer and colleagues reviewed over 12,000 tonsillectomies and reported that only 2% of the 311 children with PTH were diagnosed with a coagulopathy.<sup>10</sup> Another study

evaluating 250 PTHs identified a higher likelihood of an underlying coagulopathy in children with multiple PTH. Interestingly 38% of patients with one PTH had abnormal PT/PTT but none were diagnosed with a coagulopathy. In contrast, 13% of children with multiple PTH events were ultimately diagnosed with a bleeding disorder.<sup>11</sup>

Pre-operative treatment with disease-specific medications is possible in cases of known pre-operative coagulopathy. Of the pediatric bleeding disorders, VWD is the most common with a prevalence estimated in the United States of roughly 1%.<sup>12</sup> VWD has three subtypes with type III at the most risk for significant bleeding after major surgery. Type 1 VWD is the most common form and has been safely and successfully treated during T&A with a combination of desmopressin (DDAVP) and aminocaproic acid. Despite treatment being successful, post-operative bleeding rates were still higher amongst children with type 1 VWD as compared to healthy children.<sup>13</sup> More recently, recombinant and plasma-derived von Willebrand factor (VWF) are available and can be used in select cases.<sup>9</sup> Pharmacologic treatment should be tailored to a specific patient based on their underlying VWF levels and the expected risk of blood loss during surgery.

### Intraoperative considerations

Tonsillectomy techniques vary greatly across the United States and Europe and many published studies have looked at large cohorts of patients comparing the most common techniques of the region. Unfortunately, it is more difficult to compare multiple techniques across multiple studies, as each group employs different combinations of techniques for excision and then hemostasis after excision. Despite these difficulties, some generalizations can be made about technique relative to bleeding risk. The first broad distinction is between cold tonsillectomy techniques and those that involve either monopolar or bipolar diathermy. Most large studies conclude that the use of diathermy, monopolar or bipolar, generally increases the risk of secondary hemorrhage while cold techniques increase the risk of primary hemorrhage.<sup>14–16</sup> Since both "cold" and "hot" techniques can lead to post-tonsillectomy bleeding in different circumstances, it is unlikely that one method alone would be safest to employ in patients with diagnosed coagulopathies. A second broad distinction in technique is between partial tonsillectomy, or tonsillotomy, and total tonsillectomy. When comparing these two broad groups, there is some evidence that partial tonsillectomy has a lower rate of bleeding as compared total tonsillectomy. One systematic review comparing the two techniques compiled the data from available randomized controlled trials and found the aggregate secondary bleed rate was 0.7% for partial tonsillectomy vs 2.0% for total tonsillectomy.<sup>17</sup> Another similar systematic review found that partial tonsillectomy reduced the risk of secondary post-tonsillectomy hemorrhage by 79%.<sup>18</sup> Since this difference is most pronounced for secondary hemorrhage, surgeons who utilize diathermy for total tonsillectomy could consider a partial tonsillectomy approach in patients with a known coagulopathy as a way to potentially avoid a bleeding event post-operatively.

## Sickle cell disease

Children with sickle cell disease (SCD) are at risk of additional complications when undergoing any surgical procedure including acute chest syndrome, vaso-occlusive crisis, and acute kidney injury.<sup>19</sup> When operating on this group of patients it is vital to follow some basic principles including avoiding intravascular volume depletion, hypoxia, and significant drops in hemoglobin levels. Unfortunately, patients undergoing T&A are at risk for all of these events either intraoperatively or post-operatively. Despite the risks, T&A is beneficial in this population because it helps prevent the transient hypoxemia that can cause sickle cell crisis. Children who underwent T&A with SCD displayed decreased oxygen nadir after surgery, had fewer emergency department visits, and decreased likelihood of acute chest syndrome 1 year after surgery.<sup>20,21</sup> Because children with SCD are at risk for complications after T&A, it is common practice to administer blood transfusions pre-operatively.<sup>22</sup> Data has shown that there is no benefit to aggressive transfusion protocols in SCD patients undergoing surgery and this has been demonstrated specifically in patients undergoing T&A as well.<sup>22,23</sup> What is clear in the literature is that each SCD patient needs tailored pre-operative and intraoperative treatment by anesthesia staff based on their prior crisis history, baseline hemoglobin, and other secondary sequelae of SCD. Due to the complexity of patients with SCD prior to surgery, they should be evaluated by both anesthesia and hematology with an appropriate pre and post-operative plan in place.

## COVID-19

T&A is an open procedure where the exposed pharynx is in continuity with the circulating air of the operating room. Therefore, in most modern circumstances, powered instrumentation applied to the tonsil and adenoid tissue can generate particles that are released into the surrounding air. Particles generated during the procedure will be of varying sizes and nanoparticles can be aerosolized, putting operating room staff at risk of inhaling these particles. Airborne particles are defined by the WHO as particles less than 5  $\mu\text{m}$ , as they have the capability to remain suspended in the air and can traverse down to the level of the lower respiratory tract if inhaled.<sup>24</sup> Since T&A is theoretically capable of emitting particles in the aerosol range, it should be considered an aerosol-generating procedure (AGP). Prior to the global COVID-19 pandemic, otolaryngologists gave little thought to the potential risks to themselves or their operating room colleagues when performing AGPs such as T&A and bronchoscopy. Unfortunately, the recent pandemic has shed light on the potential transmissibility of all infectious particles during AGPs.

### Pre-operative considerations

T&A is an AGP, hence pre-operative testing should concentrate on testing for potentially harmful and prevalent pathogens that could be present in the nasopharynx or oropharynx of otherwise asymptomatic individuals. Prior to the COVID-19 pandemic, there were fortunately no

commonly occurring pathogens that met the above criteria. There is growing evidence that sars-CoV-2 viral particles are present throughout the upper respiratory tract and that the virus has a propensity for the nasal cavity and nasopharynx.<sup>25,26</sup> Therefore T&A is a surgery where you are disrupting one of the major reservoirs of sars-CoV-2 viral particles in the body. It is currently the recommendation at our institution for all patients undergoing elective otolaryngology surgery to undergo a reverse-transcriptase polymerase chain reaction (RT-PCR) test for sars-CoV-2 within 48 h prior to surgery. This practice dramatically decreases the likelihood that operating room staff will be exposed to a patient who is shedding active viral particles that could be dispersed during intubation and surgery.

While it is unlikely, it is still theoretically possible for a patient to test negative 48 h prior to surgery but still be in the early pre-symptomatic phase of the disease. In this rare scenario, a patient could have COVID-19 and be producing sufficient viral particles in their nasopharynx and oropharynx to transmit live virus during surgery. As such, appropriate personal protective equipment, including surgical masks and eye shields, should be worn even if a person has a negative RT-PCR test prior to surgery. Additionally, if the prevalence of COVID-19 is high in your area and a patient develops upper respiratory symptoms shortly after surgery, it would be prudent to test again for sars-CoV-2 infection via RT-PCR to rule out an inadvertent occupational exposure for operating room staff. If a child tests positive for COVID-19 pre-operatively, then the procedure is postponed at least 3 weeks. The child can be rescheduled within 3 months of the positive test as long as the child does not have any symptoms at the time of scheduling. A repeat test is not warranted if they are within this window.

### Intra-operative considerations

While there is no published research to date that directly addresses how surgical technique can affect the dispersal of infectious particles, there are several studies that have analyzed the surgical plume produced during tonsillectomy. Of the surgical devices utilized regularly by otolaryngologists, lasers and monopolar electrocautery (EC) are the two that have undergone the most study with regard to their surgical byproducts. Both lasers and EC devices are capable of rapidly heating tissue to its boiling point, destroying cells and releasing their contents as small particles. This surgical plume contains both viable and non-viable cellular remnants, including viruses and bacteria.<sup>27</sup> Most notably, intact viral DNA of human papillomavirus (HPV) has been detected in surgical plumes after carbon dioxide (CO<sub>2</sub>) laser treatment of verrucous lesions.<sup>28</sup> While similar studies have not yet been performed on other recent viruses of concern, such as sars-CoV-2, it is rationale to assume that intact viral particles could also be dispersed into the air in a similar manner.

One mitigation strategy that is becoming rapidly popular throughout many surgical specialties is the use of a smoke evacuator system (SES) to remove the surgical plume once it is created. Carr et al compared surgical plume production in pediatric tonsillectomy with and without the use of a SES. In addition, they compared tonsillectomy at two

different EC intensity settings. They found a higher EC setting produced higher particle number concentrations as compared to a lower setting. Additionally they found that the SES dramatically reduced the particle number concentration, so much so that a high EC setting with SES still produced fewer particles than a low EC setting without SES.<sup>29</sup> The same group published a similar study that included a third group where a surgical assistant was allowed to actively hold a suction over the surgical field. Again mean particle number concentration was lowest with tonsillectomy with SES. Tonsillectomy with manual suction produced roughly twice the particle concentration as tonsillectomy with SES and tonsillectomy without suction produced 16 times the particle concentration.<sup>30</sup>

Unfortunately to date, no specific data exists evaluating other common surgical instruments utilized during T&A, such as the Coblator wand and powered microdebrider. Both instruments utilize different methods of tissue destruction making it difficult to infer the amount of aerosolization production during surgery. Until proven otherwise, it is safer to assume that these instruments also create aerosolized particles in the respirable range and contain infectious organisms.

In highly endemic areas of COVID-19, keeping patients out of the hospital and limiting patient encounters becomes of vital importance. As discussed earlier, there is evidence to support that both post-operative pain and bleeding rates are improved in partial tonsillectomy as compared to total tonsillectomy.<sup>17,18</sup> Especially when hospital capacity is a concern, surgeons could potentially perform partial tonsillectomy to help avoid potential readmissions or return trips to the operating room. Under such dire circumstances, decreasing potential hospitalizations is beneficial for the patient and the healthcare system.

Another emerging mitigation strategy is the use of topical providone-iodine solution (PVP-I) during surgery. Historically, PVP-I solution has been utilized to decrease pre-operative microbial burden prior to procedures.<sup>31</sup> Since PVP-I solution has bacteriocidal and virucidal properties *in vitro* it is an ideal solution to apply topically to the oropharynx and nasopharynx.<sup>32</sup> In addition, 0.5% PVP-I has recently been demonstrated to completely inactivate sars-CoV-2 virus after 15 s in *in vitro* models.<sup>33</sup> PVP-I comes in several formulations and strengths but, in general, is considered safe to use in short-term applications without any significant side-effects.<sup>34</sup> Given this variability, the label should always be checked prior to use to ensure there are no flammable components, as T&A surgery has a high risk of airway fire. If deemed appropriate, PVP-I can be applied to the tonsil and adenoid tissue either with soaked cotton swabs or it can be irrigated into the oral cavity in a dilute solution.<sup>35</sup> With either application method, care should be taken to avoid inadvertent exposure of the trachea and lungs to the PVP-I solution as there have been case reports of aspiration pneumonitis after intraoral PVP-I application.<sup>36</sup> Diluting the PVP-I to the lowest effective concentration, ensuring the cuff is up with no leak from the endotracheal tube, and placing a throat pack are some strategies to decrease toxicity to the patient. It is important to note that PVP-I use has only proven effective at eliminating sars-CoV-2 on a flat surface and therefore has

no proven in-vivo clinical effect. This may be especially relevant for T&A, where the reservoir of viral particles may be within the tissue itself, which would not likely be contacted by a topical application of PVP-I.

## Conclusions

T&A is one of the most common surgical procedures performed by otolaryngologists. While most procedures are performed in children with sleep apnea or recurrent tonsillitis, it is vital to understand and prepare for other underlying comorbidities. Although children with underlying coagulopathies may be difficult to identify pre-operatively with either the lab or questionnaire methods, it is necessary to use one of these methods for screening. In cases where coagulopathy or bleeding disorder is identified, a multidisciplinary approach is recommended to manage both pre and post operatively. Additionally, the COVID-19 pandemic has made AGPs such as T&A more challenging. Surgeons should ensure proper protection for themselves and their staff and use measures to mitigate the spread of such viral infections.

## Declaration of competing interest

The authors have no conflicts of interest.

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