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Postoperative Hemorrhage and Hospital Revisit After Transoral Robotic Surgery

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Abstract

Objectives/Hypothesis—To investigate the incidence and complications related to postoperative hemorrhage (POH) after transoral robotic surgery (TORS).

Study Design—Retrospective review of the State Inpatient Database (SID), the State Ambulatory Surgery Database (SASD), and the State Emergency Department Database (SEDD) from the Healthcare Cost and Utilization Project.

Methods—Patients were identified from the SID, SASD, and SEDD for the states of Florida, New York, and California from 2005 to 2013 who had an International Classification of Diseases, Ninth Edition code for a surgical procedure on the upper aerodigestive tract associated with a code for robotic-assisted surgery. Univariate logistic regression was used to explore factors associated with POH.

Results—Five hundred nine patients underwent TORS. Indications for surgery included neoplastic disease in 376 (74%) and sleep apnea in 74 (15%). Forty-one (8%) had an episode of POH at a median of 9 days postoperatively (range = 0–21 days). Twenty-four (5%) required an intervention related to their POH. Sixteen (3%) required return to the operating room for control of hemorrhage; 11 (2%) had a severe complication that required embolization or tracheostomy. Charlson Comorbidity Score of ≥3 (odds ratio [OR] = 3.02, 95% confidence interval [CI] = 1.45–6.30) and a tonsillar neoplasm (OR = 1.96, 95% CI = 1.03–3.74) were significantly associated with POH.

Conclusions—The incidence of POH after TORS was low, and few of these patients had a severe complication related to this event. Medical comorbidity and tonsillar subsite may be independent risk factors for POH. These data provide a benchmark for informed decision making in TORS and a basis for further study.

Level of Evidence—4.

Keywords

Transoral robotic surgery; oropharynx; head and neck cancer; obstructive sleep apnea; sleep medicine

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INTRODUCTION

The use of transoral robotic surgery (TORS) has increased in recent years.[1–3] The development and refinement of transoral robotic techniques have expanded the array of applications, including sleep surgery, transoral cancer resection, and oropharyngeal reconstruction. Transoral methods avoid the morbidity of transfacial incisions and mandibulotomy, and can shorten recovery time. Although TORS is gaining popularity, the risk of catastrophic postoperative bleeding after TORS has not been fully elucidated. Because elective tracheostomy is often avoided using TORS, patients have less airway protection in the event of major postoperative hemorrhage. Serious patient morbidity associated with postoperative bleeding has been reported, including emergent tracheostomy, anoxic brain injury, and death.[4–6]

The current data exploring the risks of catastrophic bleeding after TORS are generally limited to single institution retrospective case series from tertiary care centers with small sample sizes. In one of the larger studies designed to address bleeding complications of transoral surgery, Pollei et al.[4] reviewed 906 patients who had undergone transoral oropharyngeal surgery, including both transoral laser microsurgery and TORS. They found 10 cases of severe postoperative bleeding (1.1%), with one incident of anoxic brain injury. Other authors[5,6] have reported a similar incidence of major postoperative hemorrhage, many associated with significant patient harm, including emergent tracheostomy and death. However, many transoral series do not report these complications or do not report their severity. In a recent anonymous survey of 45 TORS surgeons, six deaths within 30 days of surgery were reported, all due to catastrophic bleeds.[5] Ultimately, the true incidence and associated risk factors of major postoperative hemorrhage are not well defined.

A large statewide database including both academic and private hospitals is ideal to study such complications. In this report, the State Inpatient Database (SID), the State Ambulatory Surgery Database (SASD), and the State Emergency Department Database (SEDD) from the Healthcare Cost and Utilization Project (HCUP) were used to explore the incidence and complications associated with postoperative hemorrhage after TORS on a statewide level, including all-age and all-payer data. A critical feature of these databases is the existence of patient-specific identifiers enabling readmissions to be tracked across different hospitals, including both inpatient and emergency department (ED) visits. This offers the unique ability to capture a comprehensive picture of postoperative hemorrhage after TORS on a statewide level.

MATERIALS AND METHODS

The SID, SASD, and SEDD of the HCUP contain all-age and all-payer data from surgical patients, incorporating outpatient, inpatient, and ED clinical information. This includes the initial visit record for the index procedure as well as all revisits.[7] Importantly, these databases assign unique patient identifiers, enabling patients to be tracked across admissions and providing access to discharge records from hundreds of hospitals. In this study, the SID, SASD, and SEDD were used for the states of New York, Florida, and California. These

states have large populations and, within the HCUP, these states contain unique patient identifiers going back to 2005. For this reason, only these three states were included in this study.

The database search was conducted for Florida from 2005 to 2013, New York from 2006 to 2013, and California from 2005 to 2011, given availability of the data sets. Patients were included who were ≥18 years old who underwent a surgical procedure on the upper aerodigestive tract (UADT). These procedures were identified by the International Classification of Diseases, Ninth Edition (ICD-9) and Current Procedural Terminology (CPT) codes shown in Table I. Patients who specifically underwent TORS were identified by a UADT procedure in combination with a code for robotic-assisted surgery (ICD-9 17.4 and CPT S2900). Indications for surgery were also explored and the diagnosis of malignancy was identified by ICD-9 code as shown in Table II. Obstructive sleep apnea (OSA) was identified by ICD-9 code 327.23. Indications for surgery were considered unspecified when the diagnosis coding did not clearly specify a UADT neoplasm or OSA.

Postoperative hemorrhage was the primary outcome of interest. Patients were considered to have postoperative hemorrhage when ICD-9 codes 998.11 or 459.0 appeared during their initial hospitalization or at a subsequent hospital admission or ED revisit. Operative control of hemorrhage was identified by ICD-9 codes 39.98 and 28.7 in association with a code for postoperative hemorrhage. A severe complication of postoperative hemorrhage was defined as requiring surgical occlusion of head and neck vessels (ICD-9 38.82), endovascular embolization or occlusion of head and neck vessels (ICD-9 39.72, 39.75, 39.76), or tracheostomy (ICD-9 31.1, 31.29), or resulting in anoxic brain damage (ICD-9348.1) or brain death (ICD 9348.82) in association with a postoperative hemorrhage code. The time between the index procedure and postoperative hemorrhage event was calculated in two ways, depending on diagnosis coding. If the postoperative hemorrhage code was listed as the first diagnosis for the revisit record, it was assumed that postoperative bleeding was the indication for readmission and occurred on the first day of the revisit. However, if the postoperative hemorrhage code was listed as a secondary diagnosis in the revisit record, it cannot be precisely known when during this readmission the bleeding event occurred. In these cases, time to hemorrhage was calculated from the date of the index procedure to the midpoint of the readmission record. Similarly, if the code for postoperative hemorrhage was listed as a secondary diagnosis for the index hospitalization record, time to hemorrhage was calculated from the date of the index procedure to the midpoint between the index procedure and index discharge date.

Patient demographic, diagnostic, and treatment variables were obtained. Comorbidities, as defined by ICD-9 coding, were identified and overall severity of comorbidity was measured as defined by the Charlson Comorbidity Index.[8] Neck dissections were identified by ICD-9 codes 40.21 and 40.40–42. Postoperative infection was defined by ICD-9 codes 998.5, 998.51, and 998.59. Revisits to an ED or unanticipated hospital readmission within 30 days of the index procedure was also analyzed. Planned revisits were excluded from this analysis and defined as patients whose principal diagnosis was a neoplasm and whose hospital revisit included further UADT surgery or neck dissection. Patients whose principal diagnosis was a secondary neoplasm and who were readmitted for bronchoscopy or thoracoscopy were also

considered to be planned readmissions. ED or inpatient revisits were categorized as surgery-related, medical, or unspecified. Surgery-related revisits were defined as directly due to surgical intervention, which included postoperative bleeding, pain, and wound-related or tracheostomy-related complications. Medical complications were defined as those either indirectly related or unrelated to surgical intervention, including cardiopulmonary, renal, or hepatic conditions, dehydration, infection or bleeding at nonsurgical sites, and gastrostomy-related complications. Unspecified diagnoses were those that could not be clearly defined from the coding record. Mean and standard deviation were used to describe distribution of continuous characteristics. Frequency and relative frequency were used to describe categorical characteristics. Univariate logistic regression was used to explore factors associated with postoperative hemorrhage, and odds ratios (ORs) and 95% confidence interval (CIs) were reported. SAS Enterprise Guide 5.1 (SAS Institute, Cary, NC) was used for statistical analysis. The study was granted exempt status by the Human Research Protections Office at Washington University School of Medicine.

RESULTS

The initial database search yielded 237,582 cases of UADT surgery in Florida from 2005 to 2013, New York from 2006 to 2013, and California from 2005 to 2011. Of these, 509 were transoral robotic cases. Demographic and diagnostic data for these patients are shown in Table III. Of the 509 TORS cases, 41 (8%) patients experienced postoperative hemorrhage, at a median of 9 days postoperatively (range 5= 0–21 days). No bleeding events occurred between postoperative days 22 and 90. Sixteen (3%) patients required return to the operating room for control of hemorrhage. Eleven (2%) had a severe complication of the bleeding event, which required either embolization or tracheostomy. Several risk factors associated with postoperative hemorrhage after TORS were identified in univariate logistic regression analysis (Table III). These included overall severity of comorbidity (Charlson comorbidity score of ≥3: OR = 3.02, 95% CI = 1.45–6.30), particularly cardiac, pulmonary, and renal conditions. Additionally, the diagnosis of neoplasm as an indication for surgery was associated with postoperative hemorrhage (OR = 2.71, 95% CI = 1.04–7.06), particularly for an oropharyngeal neoplasm (OR = 3.18, 95% CI = 1.31–7.71), and specifically at a tonsillar (OR = 1.96, 95% CI = 1.03–3.74) subsite.

In patients undergoing TORS, excluding those who were readmitted for a planned procedure, 74 (15%) patients had 111 revisits within 30 days of their index procedure, either to the ED or an inpatient hospital readmission (Table IV). Twenty-two (4%) patients had multiple revisits. There were 58 outpatient ED visits, and 53 hospital readmissions. Surgery-related complications were more frequent than medical complications (51% vs. 40%). The single most common indication for revisit was postoperative hemorrhage (26%), which made up 51% of all surgery-related complications. Pneumonia and postoperative dehydration were the two most common medical complications after TORS and together made up 52% of all medical complications. When patients with the revisit indications of postoperative pain or dehydration were specifically analyzed, these accounted for 14% of patients who underwent surgery for OSA but only 3% of patients who underwent surgery for a neoplasm (difference = 11%, 95% CI = 4%−18%).

DISCUSSION

Current data describing adverse outcomes related to major postoperative hemorrhage after TORS are comprised of a heterogeneous collection of uncontrolled retrospective case series.[4,9–13] Data from such studies are restricted by methodological flaws, including recall bias, attrition bias, institutional retrospective design, and small sample sizes from limited populations. In this study, the SID, SASD, and SEDD from the HCUP were used to overcome some of these limitations. These databases capture all-age and all-payer data from a large volume of surgical patients, thus closely representing not only the patient population, but also the provider population at large. These data represent statewide experiences, helping to overcome single surgeon or single institution bias, enabling greater generalizability to all patients undergoing TORS. In addition, the SID, SASD, and SEDD incorporate unique patient identifiers, enabling patients to be followed from admission to admission across the state, limiting attrition and recall bias. Chung et al.[14] recently used the HCUP to examine the cost-effectives of TORS with the Nationwide Inpatient Sample (NIS) database and found a 4% rate of hemorrhage for partial pharyngectomy and no postoperative hemorrhage in any patient undergoing glossectomy. The NIS does not provide a unique patient identifier to track patients across admissions and therefore is likely to significantly underestimate the rate of postoperative hemorrhage. The consistency in follow-up for the SID, SASD, and SEDD, however, allows for a stable estimate of postoperative complications after TORS, and the ability to identify prognostically relevant patient factors that help to predict these complications.

In this study, the rate of postoperative hemorrhage after TORS was 8%, with severe complications including embolization or emergent tracheostomy in 2%. The risk of postoperative hemorrhage reported in large retrospective TORS series ranges from 7% to 22%.[6,9–12,15] Thus, the statewide estimate of postoperative hemorrhage after TORS, including a large number of hospitals with robust follow-up, represents the low end of the reported rate in the literature. Although 8% hemorrhage and 2% severe complication rates are appreciable and may be improved upon, using multiple hospital all-payer data, these estimates were not higher than single institution tertiary care estimates.

Risk factors for postoperative hemorrhage in this report included overall severity of comorbidity and tonsillar neoplasm. Multiple risk factors have been described in prior series, including increased age, antithrombotic medications, and higher T-stage tumors.[6,9–12,15] The risk of hemorrhage from an oropharyngeal subsite is expected, as these are often large pharyngeal wounds, left open and exposed to UADT secretions. The increased risk seen in this study for a tonsillar subsite over the base of the tongue is less clear. This is likely multifactorial and may be related to confounding variables not reported in the searched databases. For example, with TORS the tonsillar subsite may be more amenable than the base of the tongue to large tumor resections, and increasing T-stage has been previously been shown to be a risk factor for postoperative hemorrhage in transoral surgery.[4] Similarly, the increased risk of hemorrhage associated with severity of comorbidity is likely multifactorial. These patients may have platelet dysfunction or other coagulopathies, particularly those with renal or hepatic conditions. Those with cardiopulmonary disease may

have secondary hepatic insufficiency with intrinsic coagulopathies or may be taking antithrombotic medications.

In addition to hemorrhage rate and risk factors, all 30-day hospital revisits after TORS were captured using the SID, SASD, and SEDD. The single most frequent indication for revisit was postoperative hemorrhage after TORS, confirming the importance and prevalence of this complication. Apart from postoperative hemorrhage, two revisit indications, which are highly modifiable, postoperative pain and dehydration, made up almost one-quarter of all revisits. These data suggest that increased attention should be given to postoperative pain control. Revisits for postoperative pain occurred at a median of 5 days (range = 1–18 days). Postoperative pain, therefore, may peak after patients are discharged from their initial hospitalization, and appropriate counseling and medication should be provided. Similarly, hospital revisits for dehydration occurred at a median of 5.5 days (range = 2–20 days). Postoperative dehydration is likely to be related with pain or dysphagia in the early postoperative period and should be anticipated. Weinstein et al.[11] found that postoperative dysphagia was the single most common indication for hospitalization or intervention after TORS. Extended use of nasogastric tubes may be considered to bridge the peak of postoperative pain in select patients. When postoperative pain and dehydration were analyzed together, these accounted for a significantly higher proportion of revisits in patients undergoing surgery for OSA as compared to a neoplasm (14% vs. 3%). Although the etiology is unclear, similarly high rates of postoperative pain and dehydration have been previously reported after robotic sleep surgery.[16] This may be related to patient or physician expectations as well as challenges with postoperative analgesia given the risks of airway obstruction. Additionally, as postoperative pneumonia was seen in 11% of patients, overall, a more stringent swallowing evaluation and longer NPO times may be warranted in certain patients. Previous studies have shown a high incidence of postoperative pneumonia after TORS, >15% in some reports.[9,14] The other most common medical reasons for revisit included gastrostomy tube complications, thrombotic complications, and urinary tract infection. Although infrequent, these suggest that patients' postoperative care should be progressive, including early mobilization and removal of urinary catheters as soon as possible.

Although the SID, SASD, and SEDD provide robust patient continuity across admissions, use of these databases has several limitations. First, not all variables of interest are documented. It is unknown whether prophylactic transcervical vessel ligation was performed prior to or concurrently with TORS, which is thought to limit the severity of postoperative hemorrhage after transoral surgery.[4] There are no data on tumor staging, and increased T stage has previously been associated with postoperative hemorrhage after transoral surgery.[4] However, the majority of patients undergoing TORS have T1 or T2 disease, and these likely represent the majority of patients in this study.[9,11] There is also no information on current medication use, particularly regarding antithrombotic agents, which are also a known risk factor for postoperative hemorrhage.[10] Although in this study patients with more comorbidities had an increased risk of postoperative hemorrhage, these patients may also be taking antithrombotic medications, an unmeasured potentially confounding variable. Second, this study only searched the states of Florida, New York, and California, because data from these states have unique patient identifiers going back to 2005. This limits national

generalizability. These states, however, have very large populations, and are distributed geographically across the country. Third, patients who underwent a procedure in one of these states and subsequently underwent treatment for a complication in a different state will not be captured, leading to a potential underestimation of complication rates. Finally, quality of the data is dependent on the accuracy of the input from providers.

CONCLUSION

According to the SID, SASD, and SEDD of the HCUP, for the states of Florida, New York, and California, capturing a large volume of surgical patients including inpatient and emergency department revisits, the postoperative hemorrhage rate after TORS was low and not significantly higher than current tertiary care institutional series. The overall severity of comorbidity as well as a tonsillar neoplasm was associated with an increased risk of postoperative hemorrhage. Hospital revisit rates were substantial and included a significant proportion of modifiable indications, including postoperative pain and dehydration. These data establish a benchmark in TORS to track safety and outcomes improvement over time.

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TABLE I.

ICD-9 and CPT Index Surgery Procedure Codes for Upper Aerodigestive Tract Surgeries.

Code	Description
ICD-9	
25.1–4, 25.59, 25.94, 25.99	Glossectomy
27.1, 27.31–32, 27.71–72, 27.79	Palate/uvula surgery
27.49, 27.99	Other operations on oral cavity
28.2–3, 28.6, 28.92, 28.99	Tonsillectomy and/or adenoidectomy
28.5	Excision of lingual tonsil
29.0, 29.32–33, 29.39, 29.4, 29.99	Pharyngeal resection
30.01, 30.09, 30.1, 30.21–22, 20.29, 31.5	Partial laryngectomy
31.98	Other operations on larynx
CPT	
40810, 40816, 41116	Excision of mouth lesion
41110–41114, 41120, 41130, 41135, 41140, 41153, 41599, 41530,	Glossectomy
41512	Tongue suspension
41820, 41822–41827	Excision of alveolar lesion
42104, 42106, 42107, 42120, 42140, 42145, 42180, 42182, 42299	Palate/uvula surgery
42450	Excision sublingual gland
42820, 42821, 42825, 42826, 42830, 42831, 42835, 42836	Tonsillectomy and/or adenoidectomy
42808, 42842, 42844, 42845, 42890, 42892, 42894, 42950, 42999	Pharyngeal resection
42870	Excision of lingual tonsil
31510, 31512	Laryngoscopy with biopsy
31300, 31320, 31370, 31375, 31380, 31382, 31400, 31420	Partial laryngectomy

CPT = Current Procedural Terminology; ICD-9 = International Classification of Diseases, Ninth Edition.

TABLE II.

ICD-9 Diagnosis Codes for Malignant Neoplasms of the Upper Aerodigestive Tract.

Code	Description
141.0, 146.3	Malignant neoplasm of the base of tongue
141.1–9	Malignant neoplasm of the oral tongue
142.2, 144.0–1, 144.8–9	Malignant neoplasm of the floor of mouth
143.0–1, 143.8–9	Malignant neoplasm of the alveolus
145.0	Malignant neoplasm of the buccal mucosa
145.1	Malignant neoplasm of the oral vestibule
145.2	Malignant neoplasm of the hard palate
145.3–4	Malignant neoplasm of the soft palate
145.6	Malignant neoplasm of the retromolar trigone
146.0–2	Malignant neoplasm of the tonsil
146.4, 161.0–9	Malignant neoplasm of the larynx
146.5–7	Malignant neoplasm of the pharyngeal wall
148.0–9	Malignant neoplasm of the hypopharynx
149.0	Malignant neoplasm of the pharynx, unspecified

ICD-9 = International Classification of Diseases, Ninth Edition.

TABLE III.

Demographic and Diagnostic Variables and Their Association With Postoperative Hemorrhage.

Variables	Total TORS Population, N = 509, No. (%)	OR for Association With Postoperative Hemorrhage [95% CI]
Age, yr, mean ± SD	59.8 ± 12.0	1.01 [0.96–1.03]
Sex		
Male	361 (71%)	Ref
Female	148 (29%)	0.57 [0.26–1.26]
Race		
White	346 (68%)	Ref
Other	163 (32%)	0.98 [0.50–1.95]
Hospital/patient state		
New York	303 (59%)	Ref
California	50 (10%)	0.58 [0.17–1.98]
Florida	156 (31%)	0.49 [0.22–1.10]
Median household income		
Above median	335 (66%)	Ref
Below median	174 (34%)	0.45 [0.20–0.99]
Primary expected payer		
Private insurance	280 (55%)	Ref
Medicare	170 (34%)	0.82 [0.40–1.69]
Medicaid	45 (9%)	0.49 [0.11–2.17]
Other	12 (2%)	0.97 [0.12–7.81]
Comorbidity		
Overall severity of comorbidity, Charlson comorbidity score		
<3	241 (47%)	Ref
≥3	268 (53%)	3.02 [1.45–6.30]
Previous MI	17 (3%)	3.85 [1.18–12.5]
CHF	15 (3%)	4.55 [1.37–14.29]
COPD	85 (17%)	2.22 [1.08–4.55]
Diabetes	64 (13%)	1.20 [0.49–3.03]
Chronic kidney disease	24 (5%)	3.23 [1.16–9.09]

Variables	Total TORS Population, N = 509, No. (%)	OR for Association With Postoperative Hemorrhage [95% CI]
Indications for surgery		
Neoplasm	376 (74%)	2.71 [1.04–7.06]
Malignant	338 (66%)	2.22 [0.99–4.76]
Benign	38 (7%)	0.98 [0.29–3.32]
Other *	133 (26%)	Ref
Neoplasm site		
Oral cavity	24 (5%)	0.48 [0.06–3.68]
Oropharynx	338 (66%)	3.18 [1.31–7.71]
Base of tongue	144 (28%)	0.92 [0.45–1.90]
Tonsil	162 (32%)	1.96 [1.03–3.74]
Other	32 (6%)	2.27 [0.82–6.25]
Hypopharynx	*	
Larynx	*	

Other indications for surgery include obstructive sleep apnea and unspecified. Oral cavity includes oral tongue, buccal mucosa, and retromolar trigone. Other sites of the oropharynx include soft palate, pharyngeal wall, and unspecified pharyngeal locations.

* Ten or fewer patients.

CHF = congestive heart failure; CI = confidence interval; COPD = chronic obstructive pulmonary disease; MI = myocardial infarction; OR = odds ratio; Ref = reference; SD = standard deviation; TORS = transoral robotic surgery.

TABLE IV.

ED and Hospital Revisits Within 30 Days of Index Procedure.

Revisit Diagnosis	Total Revisits, N = 111
Surgery-related complications*	
Overall	57 (51%)
Postoperative hemorrhage	29 (26%)
Postoperative pain	14 (13%)
Medical complications†	
Overall	44 (40%)
Pneumonia	12 (11%)
Dehydration	11 (10%)
Unspecified	‡

*Surgery-related complications included postoperative hemorrhage, postoperative pain, wound infection, seroma, hematoma, and tracheostomy-related complications.

†Medical complications included pneumonia, dehydration, gastrostomy tube complications, heart failure, atrial fibrillation, liver failure, urinary tract infection, deep venous thrombosis, pulmonary embolism, thrush, and epistaxis.

‡Ten or fewer revisits.

ED = emergency department.