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WILEY
Readmissions Following Ambulatory Pediatric Endoscopic Sinus Surgery

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Objectives/Hypothesis: Endoscopic sinus surgery (ESS) is indicated in select pediatric patients with medically refractory sinus disease. Our objectives were to examine indications and rates of readmission following ambulatory pediatric ESS and identify specific subgroups that may benefit from inpatient admission.

Study Design: Retrospective database review.

Methods: The Pediatric Health Information Systems (PHIS) 2004–2016 database was retrospectively reviewed for patients age <18 years who underwent ambulatory ESS between January 2011 and December 2016 and were readmitted within 30 days postoperatively. Data regarding demographics, extent of surgery, comorbidities, adjunctive procedures, and cost were collected. A multivariable mixed-effects logistic regression model was employed for analysis.

Results: We identified 3,669 unique pediatric ESS cases with 128 readmissions within 30 days (3.5%; 95% confidence interval [CI]: 2.9%-4.1%). Median cost of readmission was $980 (mean, $5,890; standard deviation, $13,421). The most common indication for readmission was epistaxis (17.2%), followed by nausea/abdominal pain (14.1%). Respiratory infection (13.3%) and sinusitis (10.2%) presented a combined readmission rate exceeding that of epistaxis alone. Multivariable analysis indicated age <3 years (odds ratio [OR]: 3.41, 95% CI: 1.96-5.93) and a prior diagnosis of asthma (OR: 2.88, 95% CI: 1.99-4.18) or cystic fibrosis (OR: 1.57, 95% CI: 1.00-2.44) significantly increased the risk of readmission. Extent of ESS and simultaneous adenoidectomy, septoplasty, or turbinate reduction had no significant impact on readmission rates.

Conclusions: ESS is a relatively safe outpatient surgical procedure in pediatric patients, with an overall readmission rate of 3.5%. Clinicians should consider careful preoperative evaluation of very young patients and those with cystic fibrosis or asthma to optimize perioperative management and determine if postoperative admission is warranted, given their significantly higher readmission rates.

Key Words: Chronic sinusitis, pediatric sinus surgery, endoscopic, rhinosinusitis, readmissions.

Level of Evidence: NA

INTRODUCTION

Chronic rhinosinusitis (CRS) refractory to medical management is the principal indication for endoscopic sinus surgery (ESS) in pediatric patients. It is typically performed on an ambulatory basis in healthy children and in select children with comorbidities such as asthma, allergic rhinitis, and cystic fibrosis (CF). Studies that examine readmissions following pediatric ESS are limited. A recent review of pediatric adverse events following ESS using the National Surgical Quality Improvement Program–Pediatric (NSQIP-P) database reports a readmission rate of 4.5%, with the most common postoperative complications identified as hemorrhage and surgical-site infection.1 The authors, however, acknowledge surgical-site infection in this review was defined as any positive culture within 30 days of surgery, and further details regarding the site and source of infection were not available. Thus, this complication rate may have been overestimated. Young age (<3 years) and prior diagnosis of a bleeding disorder were associated with greater risk of requiring a blood transfusion.1 Another recent review suggests that the underlying rate of complication following pediatric ESS may approximate 2.6%; in this meta-analysis the rate of minor complications was 2%, whereas the rate of major complications was 0.6%.2

We sought to further characterize readmissions following ambulatory ESS in the pediatric population to identify groups at risk for common complications and ideally determine which children and adolescents, if any, would benefit from prolonged monitoring following ESS. We employed data from the Pediatric Health Information System (PHIS), a large nationwide database of U.S. children’s hospitals, with respect to the number, nature, and severity of readmissions during the first 7, 14, and 30 postoperative days. Our specific outcome measures included 1) overall readmission rates, 2) readmission rates associated with specific comorbid conditions such as asthma, 3) readmission rates due to severe but relatively rare complications such as orbital or intracranial injury, and 4) readmission rates for postoperative complications historically...
thought to occur more readily in the pediatric population than in adults, such as pain and dehydration. We expected different propensities for complications according to age, type (extent) of procedure performed, and presence of comorbidities such as CF, asthma, and bleeding disorders.

MATERIALS AND METHODS

This protocol was deemed exempt by the institutional review board of Boston Children’s Hospital. A search was conducted using the PHIS database for patients age >18 years who underwent one or more of the following ambulatory ESS procedures between January 1, 2010, and December 31, 2016: maxillary antrostomy with or without tissue removal (Current Procedural Terminology [CPT] codes 31267, 31256), anterior ethmoidectomy (31254), total ethmoidectomy (31255), frontal sinusotomy (31276), sphenoid sinusotomy with or without tissue removal (31288, 31287), and three or more sinusotomies (31090). Ambulatory was defined as patients who underwent surgery and were discharged home the same day as the procedure. All procedures were performed under general anesthesia. Patients who underwent nasal endoscopy with polypectomy (31237) alone were excluded. The PHIS database employs an automatic data-control system that was utilized for this study to assure a consistent, high-quality, homogenous dataset. Twenty-nine of the 45 PHIS institutions were excluded from our query due to data-quality concerns related to billing numbers, missing data, and patient disposition.

Variables extracted included demographic data, diagnoses, presence of complex chronic conditions (CCC), comorbidities, and readmissions information. The CCC classification was defined in 2000 (updated in 2014) to enable the assessment of population level trends, healthcare utilization, and patient-level outcomes. It represents “any medical condition that can be reasonably expected to last at least 12 months (unless death intervenes) and to involve either several different organ systems or one organ system severely enough to require specialty pediatric care and probably some period of hospitalization in a tertiary care center.” Other specific comorbidities examined include asthma, allergic rhinitis, and/or CF. Readmission was defined as any unplanned return to the hospital, either to the emergency department, observation unit, or inpatient floor, or for ambulatory surgery, within 30 days of discharge.

Comorbidities and concomitant procedures for included patients were identified through a stepwise process using the PHIS database. Additional PHIS reports were drawn to determine whether adjunct procedures were performed. Patients who underwent septoplasty, turbinate reduction, and/or adenoidectomy during the same instance as the ambulatory ESS were included in the analysis. Those who underwent myringotomy with or without tympanostomy tube placement were also included, as these procedures would not be expected to increase readmission rates. Patients who underwent a tonsillectomy or tonsillotomy, bronchoscopy, mastoidectomy, tympanoplasty, and/or esophagoscopy were excluded due to confounding high rates of readmission associated with these procedures. Patients were also excluded if they underwent a nasolacrimal duct probing, dacrocystorhinostomy, nasal biopsy, nasen-doscopy with polypectomy, or nasal ciliary biopsy alone. The remaining readmissions were reviewed, and all cases with indications for readmission not relevant to ESS, such as orthopedic injuries, lacerations, and the like, were excluded.

Patients were categorized by demographic data (age, sex, race/ethnicity), presence of relevant comorbid conditions (asthma, allergic rhinitis, CF, other CCs), extent of surgery, and adjunctive procedures. “Mini-ESS” was defined as maxillary antrostomy alone, ethmoidectomy alone, or maxillary antrostomy with ethmoidectomy. Patients who underwent a sphenooidotomy and/or frontal sinusotomy alone or in conjunction with any other procedures were placed in the “extended ESS” category. Data regarding days to readmission, indication for readmission, cost, and type of readmission were collected and analyzed. Type of readmission within the PHIS database is determined by the location to which the patient was admitted upon arrival at the hospital (e.g., observation unit, emergency department, ambulatory procedure, or an inpatient floor). A mixed-effects logistic regression model was used to examine risk factors for readmission among children who underwent ESS. Odds ratio (OR) and 95% confidence interval (CI) were estimated. We included hospitals as random effects in the model to appropriately account for correlation within hospital and variability that we expect between hospitals. Any variables associated with P < .05 in the univariate analysis were considered in the multivariable analysis. We then built multivariable regression model using a backward selection procedure with P < .05 as the retention criteria. Potential risk factors suggested in prior studies were also included. All analyses were performed using Stata version 13 (StataCorp LLC, College Station, TX) and SAS version 9.4 (SAS Institute, Cary, NC).

RESULTS

Patient and Procedure Characteristics

A total of 3,669 ESS procedures from 15 hospitals met inclusion criteria. This final cohort contained 2,986 unique patients. The mean age at the time of surgery was 10.0 ± 4.8 years, and 42.2% were female (Table I). Approximately 33.3% of patients had a history of asthma, 16.6% had a history of allergic rhinitis, and 11.7% were diagnosed with CF. The most common procedures performed included maxillary antrostomy alone (n = 1,444 [39.4%]) and maxillary antrostomy with ethmoidectomy (n = 1,345 [36.7%]; Table II). Extended ESS was performed in 631 patients (17.2%). Approximately one-third of patients underwent one of three adjunctive procedures: adenoidectomy (14.6%), turbinate reduction (11.6%), and septoplasty (6.7%).

Readmission Cohort

One hundred twenty-eight patients (3.5%; 95% CI: 2.9%-4.1%) were readmitted for relevant complications within 30 days of surgery (Table III). The median cost of readmission for all indications was $980 (interquartile range, $213–$4,810; mean ± standard deviation [SD], $5,890 ± $13,421). Costs ranged widely, from $103 to $109,537. Sixty percent of readmissions were limited to the emergency department; the remaining readmissions were admitted to inpatient floors (27%), underwent ambulatory surgery (9%), or were admitted to the observation unit (5%). Risk of readmission varied from 1.5% to 8.3% among hospitals, and this risk was <5.0% in 14 of the 15 hospitals. The most common indication for readmission was epistaxis (n = 22 [17.2%]). The majority of epistaxis cases (n = 18) occurred within 7 days of surgery. The mean cost of readmission for epistaxis was $2,108.62 (range, $121–$10,327; SD, $2,875.32). Five patients returned to the operating room for control of bleeding and the mean cost of their readmissions was $5,063.50 (range, $1,125–$10,327; SD, $4,275.52). Respiratory infection (n = 17 [13.3%]), sinusitis (n = 13 [10.2%]), and CF exacerbation (n = 9 [7.0%])
more commonly led to readmission between 7 and 30 days postoperatively.

**Multivariable Analysis of Risk Factors for Readmission**

Cystic fibrosis, asthma, and CCCs were associated with an increased risk of readmission in the univariate analysis (Table IV). Additionally, children age <3 years were nearly three times more likely to be readmitted than those age ≥3 years. Neither the extent of surgery (OR: 1.09, 95% CI: 0.69-1.72) nor the addition of adjunctive procedures was associated with an increased risk of readmission. Age <3 years (OR: 3.41, 95% CI: 1.96-5.93), asthma (OR: 2.88, 95% CI: 1.99-4.18), and CF (OR: 1.57, 95% CI: 1.00-2.44) were significantly associated with risk of readmission in the multivariable model (Table V).

**DISCUSSION**

Chronic rhinosinusitis in pediatric patients can have significant impact on quality of life with symptoms such as reduced sense of smell, fatigue, facial pressure, and headaches.5-8 Although most patients respond to medical therapy and/or adenoidectomy alone, patients with refractory symptoms may benefit from ESS.2,9-11 The majority of these patients have relevant comorbidities that predispose them to CRS. Our cohort demonstrated a relatively high prevalence of asthma (33.3%), allergic rhinitis (16.6%), and CF (11.7%) but a relatively low prevalence of hematological/immunological deficiency (2.7%). A prior study identified the most common morbidities in a large pediatric CRS population to be allergic rhinitis (26.9%), asthma (18.1%), immunologic disorder (12.3%), and CF (4.1%); however, this study included all patients with CRS, not solely patients with CRS severe enough to require ESS.12 Given that the majority of our pediatric CRS patients have one or more of these significant comorbidities, we sought to determine which subgroup(s) of patients may benefit from overnight monitoring following ESS. Further, there are both caregiver and economic benefits to performing ESS on an ambulatory basis, but these must be weighed against the risk and cost of hospital readmission. The average cost of a readmission following ESS in the adult population ranges from $400 for minor epistaxis to $16,877 for major complications, including cerebrospinal fluid leak, orbital hematoma, and medial rectus injury.13,14 The literature lacks a formal cost analysis of readmissions following pediatric ESS.

A recent large retrospective cohort study examining 2,061 pediatric ESS procedures from a national perspective using the NSQIP-P database reported a 4.5% rate of readmission. Their results indicated a significantly increased risk of readmission for patients age <3 years. In addition, patients with congenital or acquired bleeding disorders experienced significantly higher rates of readmission. To validate and expand upon the current literature, we utilized the PHIS database to investigate readmission rates following pediatric ESS from a similar but different national perspective. The PHIS contains data on all patients evaluated at select pediatric hospitals across the United States, producing a larger sample size than previously assessed. Restricting our extraction to ambulatory procedures and closely examining the indications for readmission for all patients enabled a focus on high-quality data. Prior literature did not distinguish between ambulatory and emergency procedures, potentially yielding an augmented rate of readmission due to additional complications that may arise in emergency situations.1 The PHIS also enabled us to identify common adjunctive procedures, such as septoplasty, to determine whether concomitant procedures increase the risk of readmission. We also improved upon the current literature by employing standard errors clustered at the hospital level, allowing for more accurate estimates of the variability of readmission rates with respect to our variables of interest.

In our cohort, the overall readmission rate was 3.5% (95% CI: 2.9%-4.1%), which indicates that ESS is a relatively safe outpatient procedure for most patients. The most common indication for readmission was epistaxis (17.2%), with the majority (17/22) of these readmissions occurring within the first week following surgery. Of the 22 readmissions due to epistaxis, nine (40.9%) were admitted to the hospital from the ED and five (22.7%) returned to the
operating room for hemorrhage control. The mean cost of readmission for epistaxis was $2,109 (range, $121–$10,327; SD, $2,875), and this cost more than doubled if a patient required a secondary surgical intervention (mean cost, $5,063). Because the majority of bleeding occurs within the first postoperative week, clinicians should consider restricting postoperative activity for 1 week after surgery to minimize this risk. In addition, caregivers should be reassured that the overall risk of bleeding following surgery is 0.6% (22/3,669).

Similar to the NSQIP-P study, patients age <3 years had a significantly higher readmission rate (OR: 2.59, 95% CI: 1.48-4.55). Patients age <3 years comprised 5.3% of all patients in our cohort and 9.2% of patients requiring readmission. The most common indication for ESS in those who required readmission was chronic maxillary sinusitis. Patients with asthma also had a nearly three-fold higher risk of readmission than patients without asthma. Of the readmitted asthma patients, about 27% returned due to respiratory issues, and the majority of these patients were readmitted within a week of the initial procedure. We were unfortunately not able to discern between patients with mild, moderate, and severe asthma using the dataset. However, these data indicate that consideration should be given to postoperative admission for very young patients with asthma undergoing ESS.

Patients with CF were also at higher risk for readmission (OR: 1.57) following ambulatory ESS. Of the patients with CF, 35% returned due to CF exacerbation; therefore, clinicians should consider postoperative admission for this subgroup as well. Other common indications for readmission in this group included epistaxis and constipation. Given these findings, monitoring for epistaxis during chest physiotherapy and instruction regarding bleeding management should be reviewed with patients prior to discharge. In addition, the use of laxatives should be considered, particularly if postoperative narcotics are prescribed.

Readmissions due to pain (5.5%) and dehydration (4.7%) are unique to the pediatric population. We found these complications were also more likely to occur within the first postoperative week. Both of these issues may be
related to poor pain control, emphasizing the importance of ensuring adequate pain control and oral intake prior to discharge.

Delayed complications requiring readmission included respiratory infection (13.3%) and sinusitis (10.2%). Based on the dataset, it is difficult to determine which percentage of these were viral upper-respiratory-tract infections versus acute bacterial infections. An institutional study examining readmission rates for these indications would be helpful in this regard.

According to the literature, the risk of major orbital or intracranial complications following pediatric ESS is <1%. The incidence in our patient cohort was 0.2% (8/3669). Two patients in our cohort (1.5%) may have experienced an orbital complication, as they presented with eyelid swelling on the third postoperative day. Six patients (4.5%) were readmitted between the second and 17th postoperative days with altered mental status or seizures, indicating possible intracranial complications. Three of these six patients, however, had a known diagnosis of epilepsy, and therefore this number may be overestimated. The charts of the remaining three patients were reviewed and did not indicate a neurologic or seizure disorder history.

Almost 80% of patients underwent a mini-ESS, defined as maxillary antrostomy and ethmoidectomy. The risk of readmission did not differ between the mini-ESS patient cohort (3.4%) and those requiring extended ESS (3.8%; OR: 1.09, 95% CI: 0.69-1.72). These findings are consistent with a recent study that likewise found more extensive surgery not to be associated with an increased risk of postoperative complication. Similarly, patients who underwent a concomitant septoplasty, turbinate reduction, and/or adenoidectomy were not more likely to be readmitted. This is an important finding with regard to the relative risks of multiple anesthetics versus the prolonged duration of multiple procedures in pediatric patients. This indicates that adjunctive procedures can safely be performed in conjunction with outpatient ESS in children.

This study has several limitations. As with any retrospective study, we are limited to data that has been collected for purposes other than the study. Because we relied upon a national database, data may have inadvertently been miscoded or excluded. Moreover, the PHIS database only contains data from hospitals within the Children’s Hospital Association, so patients presenting to outside hospitals following ESS are not captured here. In addition, only pediatric patients with CRS severe enough to warrant surgery were included; thus, the results of this study may only apply to this select population. Despite these limitations, this study represents the largest cohort of the pediatric ESS population examined to date.

CONCLUSION

Endoscopic sinus surgery is a relatively safe ambulatory procedure with an overall readmission rate of 3.5% and a major complication rate of 0.2%. The results suggest an increased risk of readmission in patients with preexisting asthma or CF, and in young patients age <3 years. Physicians and caregivers should be aware of these risk factors and consider postoperative admission in these high-risk groups.

BIBLIOGRAPHY