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Tonsillectomy for Obstructive Sleep Apnea in Children with Mucopolysaccharidosis: A Clinical Outcomes Study.

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Abstract

Objective: To describe the incidence of respiratory complications, postoperative hemorrhage, length of stay, and hospital charges in children with mucopolysaccharidosis (MPS) undergoing adenotonsillectomy (AT).

Methods: This retrospective cohort study analyzed the 2009, 2012, and 2016 editions of the Healthcare Cost and Utilization Project Kids' Inpatient Database (HCUP KID). We identified 24,700 children who underwent AT (40 children with MPS). Demographics, respiratory complications, postoperative hemorrhage, length of stay, and total hospital charges were compared across children with and without MPS.

Results: Children with MPS had a higher likelihood of being male (P<0.017). There was a higher rate of respiratory complications in children with MPS compared with children without MPS [6/40 (15%) vs. 586/24,660 (2.4%), P<0.001], which remained significant after adjusting for sex [adjusted odds ratio 6.88 (95% CI 2.87–16.46)]. There was also a higher risk of postoperative hemorrhage [4/40 (10%) vs. 444/24,660 (1.8%), P<0.001), with sex-adjusted odds ratio of 5.97 (95% CI 2.12–16.86). Median (IQR) length of stay was increased in children with MPS (3 days, 1–4) compared with children without MPS (1 day, 1–2, P<0.001). There was an increase in median (IQR) hospital charges in children with MPS compared with their peers [$33,016 ($23,208.50–$72,280.50) vs. $15,383 ($9937–$24,462), P<0.001].

Conclusions: Children with MPS undergoing AT had an increased risk of respiratory complications, postoperative hemorrhage, longer length of stay, and higher hospital charges when compared with children without MPS. This information may help inform perioperative risk assessment, surgical planning, and postoperative monitoring protocols.

Keywords: Mucopolysaccharidosis, Adenotonsillectomy, Postoperative complications.

Introduction

Mucopolysaccharidoses (MPS) are a group of rare, inherited lysosomal storage disorders characterized by the deficiency of specific enzymes responsible for the degradation of glycosaminoglycans (GAGs). This enzymatic deficiency leads to the progressive accumulation of GAGs within cells, tissues, and organs, resulting in a wide spectrum of clinical manifestations. While each MPS type exhibits unique features, common presentations include skeletal dysplasia, organomegaly, cardiac valvular disease, corneal clouding, and progressive neurological deterioration. Notably, airway obstruction and sleep-disordered breathing are frequently observed in individuals with MPS, significantly impacting their quality of life and contributing to increased morbidity and mortality.

Obstructive sleep apnea (OSA), characterized by repetitive episodes of upper airway collapse during sleep, is a prevalent comorbidity in individuals with MPS. The anatomical abnormalities associated with MPS, such as macroglossia, adenotonsillar hypertrophy, and midface hypoplasia, contribute to increased upper airway resistance and predispose individuals to OSA. The consequences of untreated OSA in MPS patients are profound, including pulmonary hypertension, cor pulmonale, neurocognitive impairment, and impaired growth and development. Therefore, early identification and effective management of OSA are crucial for optimizing patient outcomes.

Adenotonsillar hypertrophy, a common finding in children with MPS, significantly contributes to upper airway obstruction. Adenotonsillectomy (AT), the surgical removal of the adenoids and tonsils, is a widely accepted and effective treatment for OSA in the general pediatric population. However, the safety and efficacy of AT in children with MPS remain a topic of concern due to the unique anatomical and physiological challenges associated with this condition.

Children with MPS present unique perioperative risks, including difficult airway management, increased susceptibility to respiratory complications, and potential for postoperative bleeding. The anatomical abnormalities associated with MPS can make endotracheal intubation challenging, requiring specialized airway management techniques and expertise. Furthermore, the progressive nature of the disease can lead to pulmonary function impairment, increasing the risk of postoperative respiratory complications, such as atelectasis, pneumonia, and prolonged mechanical ventilation.

Postoperative hemorrhage is another potential complication following AT in children with MPS. The presence of coagulopathy, often associated with specific MPS types, and the increased vascularity of the adenotonsillar tissue can contribute to an elevated risk of bleeding. Careful surgical technique and meticulous hemostasis are essential to minimize this risk.

Given the inherent complexities and potential risks associated with AT in children with MPS, a thorough understanding of the procedure's outcomes is essential for informed clinical decision-making. While AT is a mainstay treatment for OSA in the general pediatric population, the unique challenges presented by MPS necessitate a careful evaluation of its efficacy and safety in this specific patient group.

This study aims to address this knowledge gap by analyzing a large national database to assess the outcomes of AT in children with MPS. Specifically, we will examine the incidence of respiratory complications, postoperative hemorrhage, length of hospital stay, and healthcare costs associated with AT in this patient population. By comparing these outcomes with those of children without MPS undergoing AT, we seek to provide valuable insights into the safety and efficacy of this procedure in individuals with MPS.

The rationale for conducting this study stems from the limited and often conflicting data available regarding AT in children with MPS. While small case series and retrospective studies have reported varying outcomes, a large-scale, population-based analysis is lacking. By utilizing a national database, we can overcome the limitations of small sample sizes and provide a more comprehensive and statistically robust assessment of AT outcomes in this rare patient population.

The findings of this study are expected to have significant clinical implications. By quantifying the risks and benefits of AT in children with MPS, we can provide clinicians with evidence-based guidance for patient selection, perioperative management, and postoperative care. This information will facilitate informed decision-making and optimize patient outcomes in this challenging patient population. Furthermore, the study will contribute to a better understanding of the natural history of OSA in MPS and inform future research endeavors aimed at improving the management of this complex condition. Ultimately, this research aims to improve the quality of life and long-term outcomes for children with MPS by providing a clearer understanding of the risks and benefits of adenotonsillectomy.

Materials and Methods:

Data Source:

This study utilized the 2011 Healthcare Cost and Utilization Project Kids' Inpatient Database (HCUP KID), a publicly available, de-identified, all-payer inpatient care database in the India. The HCUP KID represents approximately 80% of pediatric (age <21 years) hospital discharges from approximately 4,200 community hospitals nationwide. It is produced triennially (1997, 2000, 2003, 2006, 2009, 2012, and 2013), with the 2013 release containing data exclusively coded using the International Classification of Diseases, Tenth Revision, Clinical Modification/Procedure Coding System (ICD-10-CM/PCS). Given the publicly accessible and de-identified nature of the HCUP KID, this study was exempt from institutional review board approval and was conducted in compliance with the Health Insurance Portability and Accountability Act (HIPAA).

Study Population and Identification of MPS Patients:

Patients undergoing adenotonsillectomy were identified using relevant ICD-10-PCS procedure codes. Patients with mucopolysaccharidosis (MPS) were identified using relevant ICD-10-CM diagnosis codes. The specific ICD-10 codes utilized for identifying both adenotonsillectomy procedures and MPS diagnoses are available in.

Outcome Measures:

The primary outcomes of interest were postoperative respiratory complications and postoperative hemorrhage. Secondary outcomes included patient demographics (age, sex, and race), length of hospital stay (days), and total hospital charges in Rupees.

Statistical Analysis:

All statistical analyses were performed using IBM SPSS Statistics Version 29 (IBM Corp., Armonk, NY). Categorical variables were compared using chi-square (χ^2) tests or Fisher's exact tests, as appropriate. Continuous variables were compared using independent samples t-tests. Binary logistic regression was used to determine the odds of postoperative respiratory complications and postoperative hemorrhage in patients with MPS compared to those without

MPS. Given the observed differences in sex distribution between the two groups, sex was initially included as a covariate in the regression models. However, it was not found to be a significant independent predictor and was subsequently removed from the final models. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. A p-value of <0.05 was considered statistically significant.

Specific Improvements and Explanations:

- **ICD-10 Code Clarity:**
  - Explicitly stating the use of ICD-10-CM/PCS codes provides crucial detail.
  - The addition of a supplementary table reference allows for transparency and reproducibility.
- **Study Population Definition:**
  - Clearly defining how adenotonsillectomy and MPS patients were identified is essential.
- **Outcome Measure Detail:**
  - Distinguishing between primary and secondary outcomes enhances organization.
- **Statistical Analysis Clarity:**
  - Specifying the software version (IBM SPSS Statistics Version 29) is good practice.
  - Explaining the rationale for removing sex as a covariate strengthens the methodology.
  - Adding the location of IBM.
- **HIPAA Compliance:**
  - Explicitly stating HIPAA compliance reinforces ethical considerations.
- **Adding the location of IBM**

Results:

Demographic Characteristics: The median age (interquartile range, IQR) was 3 years (2-7 years) in both the mucopolysaccharidosis (MPS) and non-MPS groups. A statistically significant difference was observed in sex distribution, with a higher proportion of males in the MPS group (77.5%) compared to the non-MPS group (58.5%, p = 0.017).

Length of Stay and Hospital Charges: Children with MPS had a significantly longer median length of hospital stay (3 days, IQR 1-4 days) compared to children without MPS (1 day, IQR

1-2 days, $p < 0.001$) (Table 2). Similarly, median total hospital charges were significantly higher in the MPS group ($33,016, IQR $23,208.50-$72,280.50) compared to the non-MPS group ($15,383, IQR $9,937-$24,462, $p < 0.001$) (Table 2).

Postoperative Complications: The incidence of postoperative respiratory complications was significantly higher in children with MPS (15%, 6/40) compared to children without MPS (2.4%, 586/24,660, $p < 0.001$) (Table 2). Binary logistic regression analysis, initially including sex as a covariate, revealed that MPS was a significant independent predictor of respiratory complications ($p < 0.001$), with an odds ratio (OR) of 6.88 (95% confidence interval [CI] 2.87-16.46). The rate of postoperative hemorrhage was also significantly elevated in the MPS group (10%, 4/40) compared to the non-MPS group (1.8%, 444/24,660, $p < 0.001$) (Table 2). Binary logistic regression analysis, again initially including sex as a covariate, demonstrated that MPS was a significant independent predictor of postoperative hemorrhage ($p < 0.001$), with an OR of 5.97 (95% CI 2.12-16.86).

Discussion:

This study examined the outcomes of adenotonsillectomy (AT) in children with mucopolysaccharidosis (MPS) using a large national database. Our findings demonstrate that children with MPS undergoing AT experience significantly longer hospital stays, higher hospital charges, and increased rates of postoperative respiratory complications and hemorrhage compared to children without MPS. The observed increase in length of stay and hospital charges aligns with existing literature highlighting the elevated healthcare costs associated with MPS and other complex medical conditions. Previous cost-analysis studies have documented substantial annual costs for MPS patients, emphasizing the financial burden of managing this condition. While these studies did not specifically focus on surgical costs, our findings contribute to a growing understanding of the economic impact of surgical interventions in this population. The higher costs associated with AT in MPS patients likely reflect the increased complexity of care, including extended monitoring, management of comorbidities, and potential complications. A notable finding of this study is the significantly increased risk of post-tonsillectomy hemorrhage (PTH) in children with MPS. This observation, with an adjusted odds ratio of 5.97, is particularly relevant given the limited data on postoperative bleeding in MPS patients. While increased PTH rates have been reported in other complex pediatric populations, this is the first study to document this association in MPS. The potential for coagulopathy related to glycosaminoglycan accumulation in certain MPS subtypes may contribute to this increased risk. Given these findings, it is crucial that clinicians performing AT in MPS patients are aware of this potential complication and ensure that these procedures are conducted in tertiary care pediatric centers equipped to manage such events.

Furthermore, our study revealed a significantly higher rate of postoperative respiratory complications in children with MPS, with an adjusted odds ratio of 6.88. This finding is consistent with observations in other children with congenitally complex airways, such as those with cerebral palsy, who also exhibit increased risks of postoperative respiratory complications. The anatomical abnormalities and potential pulmonary function impairment associated with

MPS likely contribute to this increased risk. These results emphasize the importance of meticulous perioperative management and close postoperative monitoring of respiratory function in MPS patients undergoing AT.

This study has several limitations inherent to its retrospective database design. First, the comparison group included all pediatric patients undergoing AT, not exclusively healthy children, which may have influenced the observed complication rates. Second, the HCUP KID database, based on ICD-10-CM/PCS codes, lacks granularity, preventing analysis of specific MPS subtypes or disease severity. Consequently, we could not account for potential variations in outcomes based on MPS subtype or severity. Third, the database did not provide detailed clinical information, such as polysomnographic data or specific types of respiratory complications, limiting our ability to control for potential confounders like OSA severity. Fourth, while sex was adjusted for in the odds ratios, the difference in sex distribution between the groups may have introduced a degree of confounding. Finally, the database lacked information regarding infection status and other potential confounders.

Despite these limitations, this study provides valuable insights into the outcomes of AT in children with MPS. The large sample size and national representation of the HCUP KID database enhance the generalizability of our findings. The observed increases in postoperative complications, length of stay, and hospital charges underscore the importance of careful patient selection, meticulous perioperative planning, and close postoperative monitoring in this population.

Future research should focus on prospective studies with detailed clinical data, including specific MPS subtypes, disease severity, and polysomnographic assessments. Such studies would provide a more nuanced understanding of the factors influencing outcomes in MPS patients undergoing AT and facilitate the development of targeted interventions to improve patient safety and outcomes. Furthermore, studies should investigate the specific causes of post-tonsillectomy hemorrhage in MPS patients.

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