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Sedation-related outcomes in postoperative management of pediatric laryngotracheal reconstruction

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ABSTRACT

Objective: Examine outcomes of varied postoperative sedation management in pediatric patients recovering from single stage laryngotracheal reconstruction.
Design: Retrospective review of 34 patients treated with single stage laryngotracheal reconstruction from 2001 through 2011.
Setting: Tertiary children's hospital.
Methods: Patients were divided into 2 groups: those managed postoperatively with sedation, with or without paralysis (group 1), and those managed awake with narcotic pain medication as needed for primary management (group 2). Outcomes were measured as a function of sedation management. Outcomes investigated focused on those related to the success of the airway reconstruction, and those related to sedation management.
Results: Out of 68 cases of laryngotracheal reconstruction reviewed from 2001 to 2011, 34 were single stage reconstructions. Nineteen patients were sedated postoperatively (group 1) and fifteen patients were left awake (group 2). There were no significant differences between groups in airway-related outcomes, including risk of accidental decannulation, revision rates, and need for secondary airway procedures such as balloon dilation. Sedation-related outcomes, specifically focusing on differences in medical management, showed significant increases in rates of withdrawal ($p < 0.0001$), nursing concerns of withdrawal ($p < 0.0001$) and sedation level ($p < 0.0001$), pulmonary complications (OR 7.7, $p = 0.008$), and prolonged hospital stay due to withdrawal ($p = 0.0005$) in patients managed with sedation with or without paralysis. Multivariable regression analysis revealed that duration of sedation was the primary risk factor for increased postoperative morbidity, while younger age, lower weight, and use of a posterior graft were also significant variables assessed.
Conclusion: Avoiding sedation as the standard for postoperative management of single stage laryngotracheal reconstruction airway patients leads to an overall decreased risk of morbidity without increasing risk of airway-specific morbidity. This is specifically as related to withdrawal, pulmonary complications, concerns about sedation level and prolonged hospital course, all of which increase significantly with increased level and duration of sedation.

1. Introduction

Intubation in the pediatric population carries the risk of laryngotracheal stenosis [1]. Low birth weight and neonatal patients are particularly vulnerable, with an incidence of 0.63–2% [1,2] Currently, open laryngotracheal reconstruction (LTR) with cartilage augmentation of the airway is the accepted standard of care for surgical management [3]. Single stage LTR (ssLTR) is one variation of airway reconstruction initially described in the early 1990s, which allows for avoidance of a tracheostomy. In cases of a pre-existing tracheostomy, the tracheostomy site itself is incorporated into the graft reconstruction [4]. Postoperative management

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in these patients focuses on maintaining a secure airway for the duration of healing while achieving patient comfort and minimizing morbidity. Historically, a focus on decreasing the potential morbidity associated with accidental decannulation or excessive endotracheal tube movement led to the adoption of prolonged sedation, often with paralysis, in postoperative management [5,6]. Utilization of such methods has been associated with notable complications, including withdrawal, symptomatic atelectasis, prolonged neuromuscular weakness, and exacerbation of reactive airway disease [5,7–9]. Such complications contribute to increased patient morbidity, and may lead to prolonged pediatric intensive care unit (PICU) and hospital stay. Several centers have described alternative methods for postoperative management of patients after LTR using minimal sedation and paralysis, typically in older, more developed children [7,10]. The postoperative management of ssLTR patients is currently quite variable between surgeons, as evidenced by the lack of standardization in the literature. Additionally, there is a lack of literature comparing the safety and efficacy of contrasting approaches. It is important to define outcome measures specific to the method of postoperative sedation in order to offer the most optimal care – to decrease morbidity while simultaneously maintaining acceptable surgical results and a safe postoperative course. This was uniquely feasible at our institution, as surgeon-directed postoperative management differs within the division, allowing for selection of two separate groups of patients undergoing ssLTR: those managed with sedation (with or without paralysis) and those managed awake with as-needed narcotic pain medication as primary management. Outcomes investigated between groups focused on airway-related outcomes and the safety of minimal postoperative sedation, as well as sedation-related outcomes such as withdrawal.

2. Materials and methods

2.1. Patient selection

The study was approved by the Colorado Multiple Institutional Review Board (COMIRB). A retrospective chart review was conducted over a 10-year period between 2001 and 2011 at Children's Hospital Colorado, Aurora, CO. Patients who had undergone surgical correction of subglottic stenosis were identified based on ICD-9 and CPT codes. All patients undergoing ssLTR and recovering in the pediatric intensive care unit (PICU) were included in the study. Patients having undergone anterior double stage LTR, cricoid split, tracheal resection, and cricotracheal resection were excluded. Patients who spent the postoperative period in the neonatal ICU were also excluded, as their hospital course was not based on airway reconstruction alone.

2.2. Variables and outcome measures

Perioperative variables collected included gender, age, weight, comorbidities (including prematurity class) Cotton–Myer grade and etiology (acquired/congenital) of stenosis, preoperative time with tracheostomy (if applicable) and type of graft used (anterior/posterior/combined). Postoperative variables recorded included sedation level (none/minimal vs. moderate/heavy), sedative agents used (opioid, benzodiazepine, or dexmedetomidine), and use of neuromuscular paralytics. Hospital length of stay, PICU length of stay, and reasons for prolonged stay (if applicable) were noted. Postoperative complications were recorded, including specific mention in progress notes by MD provider of withdrawal or withdrawal signs (e.g. insomnia, tremors, diaphoresis, fever), use of withdrawal medications (methadone, clonidine, lorazepam), nursing concerns of sedation level (defined as specific mention by nursing staff of inappropriately light sedation in non-sedated patients, or tolerance to sedative medications requiring increased sedation or paralysis for sedated patients), specific mention by nursing staff of concern for withdrawal or withdrawal signs (as defined previously), symptomatic atelectasis (diagnosed by chest imaging and leading to requirement for supplemental oxygen or intervention such as bronchoscopy), pneumonia (as diagnosed by chest imaging), accidental-extubation (defined as premature self-removal of nasotracheal tube), need for tracheostomy replacement, and need for additional procedures (including balloon dilation and LTR revision).

2.3. Statistical analysis

Outcomes examined included those related directly to sedation and those related directly to LTR. LTR-related outcomes examined included: additional procedures, accidental extubation, and rate of failure or revision. Sedation-related outcomes included: documented withdrawal, nursing concerns regarding withdrawal signs or difficulty achieving comfort/sedation level, pulmonary complications, length of PICU and hospital stay and factors influencing prolonged stay (if applicable). Chi-squared analysis, Fisher's exact test, and Wilcoxon–Mann–Whitney test were used to examine relationships between variables and outcomes. Univariate and multivariable logistic regression analysis was conducted to determine significant predictors of binary outcomes. Kaplan–Meier plots were used to estimate probabilities of PICU and hospital discharge, and Cox's proportional hazards regression model was used to estimate hazard ratios for predictors of length of PICU and hospital stay. SAS version 9.3, JMP version 10.0.2 (Cary, NC) and R version 2.15.3 were used for all statistical analyses.

2.4. Sedation management

Determination for post-operative sedation management was dictated initially by attending surgeon, with subsequent input from the PICU team. Patients were grouped based on level of sedation. Patients in group 1 were considered sedated, with or without paralysis. PICU documentation of sedative agents used and whether used on as-needed (PRN) or continuous (GTT) method was recorded. Sedated patients universally required ventilator support. Patients in group 2 were considered awake or non-sedated. These patients were permitted sedation for the initial post-anesthesia period, with a goal of weaning sedation by 12–24 h. Non-sedated patients were permitted continuous positive airway pressure (CPAP) use as needed but otherwise did not require ventilator support. All patients were managed post operatively with nasotracheal intubation.

At our institution, preparation of postoperative management begins in the preoperative time period with discussion with parents, patients, and anesthesia care teams. If a patient is deemed appropriate by the parents and surgeons for non-sedated management, then immediately following the surgery, the patient is awakened in the operating room, allowed to exit stage 2 of anesthesia and brought to the PICU, with minimal sedation thereafter. After sedation is discontinued, patients are then managed for pain control alone. They are able to breathe through a Heat Moisture Exchanged (HME) adapter attached to the nasotracheal tube, with intermittent CPAP at night if needed, in order to prevent atelectasis. On the first postoperative day, oral intake is reintroduced, and patients are encouraged to ambulate and resume light activity throughout the course of intubation. Sedated patients remain mechanically ventilated and sedated upon admission to the PICU. These patients have a goal sedation level that ensures the patient is comfortable, and that risk for accidental extubation is minimized. Neuromuscular blockade may be added when it is felt that sedation alone is not adequate for prevention of these events.