Journal of Pediatric Surgery 53 (2018) 352–356

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Definitive airway management after prehospital supraglottic rescue airway in pediatric trauma☆

Matthew C. Hernandez [b], Ryan M. Antiel [a], Karthik Balakrishnan [c], Martin D. Zielinski [b], Denise B. Klinkner [a,*]

[a] Department of Pediatric Surgery, Mayo Clinic, Rochester, MN
[b] Department of Trauma, Critical Care and General Surgery, Mayo Clinic, Rochester, MN
[c] Department of Otolaryngology, Mayo Clinic, Rochester, MN

ARTICLE INFO

Article history:
Received 3 October 2017
Accepted 4 October 2017

Key words:
Supraglottic airway
Trauma
Pediatric
Prehospital
ATLS

ABSTRACT

Introduction: Supraglottic airway (SGA) use and outcomes in pediatric trauma are poorly understood. We compared outcomes between patients receiving prehospital SGA versus bag mask ventilation (BVM).
Methods: We reviewed pediatric multisystem trauma patients (2005–2016), comparing SGA and BVM. Primary outcome was adequacy of oxygenation and ventilation. Additional measures included tracheostomy, mortality and abbreviated injury scores (AIS).
Results: Ninety patients were included (SGA, n = 17 and BVM, n = 73). SGA patients displayed increased median head AIS (5 [4–5] vs 2 [0–4], p = 0.001) and facial AIS (1 [0–2] vs 0 [0–0], p = 0.03). SGA indications were multiple failed intubation attempts (n = 12) and multiple failed attempts with poor visualization (n = 5). Median intubation attempts were 2 [1–3] whereas BVM patients had none. Compared to BVM, SGA patients demonstrated inadequate oxygenation/ventilation (75% vs 41%), increased tracheostomy rates (31% vs 8.1%), and increased 24-h (38% vs 10.8%) and overall mortality (75% vs 14%) (all $p < 0.05$).
Conclusions: Escalating intubation attempts and severe facial AIS were associated with tracheostomy. Inadequacy of oxygenation/ventilation was more frequent in SGA compared to BVM patients. SGA patients demonstrate poor clinical outcomes; however, SGAs may be necessary in increased craniofacial injury patterns. These factors may be incorporated into a management algorithm to improve definitive airway management after SGA.

Inadequate airway management may lead to cardiovascular arrest and complicate subsequent life-saving interventions in the injured patient [1]. Several airway control devices and techniques are available to assist prehospital providers in order to maintain ventilation and oxygenation. These include bag valve mask (BVM) ventilation, direct laryngoscopy with endotracheal intubation (ETI) and adjunct supraglottic airway devices such as the laryngeal mask airway, Combitube, and King Airway Device (King LT-D; King Systems, Noblesville, IN) [2]. Despite the variety of options available to secure the airway, there is a paucity of data evaluating the outcomes of supraglottic rescue airway devices, especially in pediatric trauma.

In the pediatric population, prehospital airway interventions may not be superior to BVM ventilation. Previous work has demonstrated moderate prehospital ETI failure rates with subsequent tube malposition [7–11]. These studies concluded that prehospital pediatric advanced airway interventions may not be necessary to achieve adequate ventilation/oxygenation while also recognizing that a proportion of patients may require advanced airway control maneuvers, including supraglottic rescue airway insertion. Supraglottic rescue airway devices may provide an alternative method to achieve airway control. Currently, no studies (1) describe supraglottic rescue airway utilization in pediatric trauma patients or (2) compare this adjunct to the standard of care (BVM). This makes it difficult to estimate how these devices might affect airway and trauma outcomes [12].

Supraglottic rescue airways provide more facile airway control for difficult airway patients. However, they are not without risk and may have size limitations in smaller pediatric patients [2,13–15]. Complications from insertion range from malposition to dislodgement [16–18]. Furthermore, the optimal method for safe transition to a definitive airway and the most appropriate definitive airway type have yet to be determined [19,20]. Therefore, the objective of this study is to compare outcomes, specifically adequacy of oxygenation and/or ventilation at time of admission among pediatric patients who received prehospital supraglottic airways versus BVM ventilation. We hypothesize that patients with increased craniofacial injury patterns and difficult airways in the prehospital setting would be more likely to require advanced airway techniques, including surgical tracheostomy, as a definitive airway.

☆ The authors have no financial conflicts for the generation of this work. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
* Corresponding author at: Mayo Clinic, 200 First Street SW, Rochester, MN 55905.
E-mail addresses: Hernandez.matthew@mayo.edu (M.C. Hernandez), Antiel.ryan@mayo.edu (R.M. Antiel), Balakrishnan.karthik@mayo.edu (K. Balakrishnan), Zielinski.martin@mayo.edu (M.D. Zielinski), Klinkner.denise@mayo.edu (D.B. Klinkner).

https://doi.org/10.1016/j.jpedsurg.2017.10.004
0022-3468/

1. Methods

1.1. Patient identification

This study was approved by the Mayo Clinic Institutional Review Board. We performed a single center retrospective study that examined patients who were ≤18 years old and incurred multisystem trauma during 2005–2016. Multisystem trauma was defined as an Injury Severity Score of ≥9. Patients were identified from the Mayo Clinic Trauma Center database for (1) insertion of a supraglottic rescue airway (King Airway Device, King LT-D, Noblesville, IN) or (2) prehospital bag valve mask ventilation (BVM) with subsequent endotracheal intubation (ETI) in the resuscitation bay after airway evaluation. Patients who received endotracheal intubation in the prehospital setting, received a supraglottic rescue airway device other than a King LT-D, refused consent to research, and who did not display multisystem trauma (ISS <9) were excluded.

1.2. Institutional prehospital airway care

Patients were transported by rotor wing or via ground transportation. Patients that were transported by rotor wing received care from critical care trained flight nurses. Patients that were transported via ground transportation received care from paramedics. At our institution, injured patients that require advanced prehospital airway management meet criteria for our highest level trauma team activation. Emergency Medicine, Surgery, and Anesthesia physicians are present in the trauma resuscitation bay at patient arrival. For patients ≤14 years of age, the pediatric surgeon responds within 15 min, and the pediatric critical care physician also responds. Each prehospital airway intervention is reviewed in detail by the directors of Medical Transportation, Emergency Medicine, Trauma Surgery, and Anesthesia. A prehospital advanced airway control algorithm has been defined and implemented by this group for standardized practice and safe patient care. See Fig. 1.

1.3. Primary outcome and secondary predictors

Primary outcome was adequacy of oxygenation and ventilation at the time of hospital arrival. Inadequate oxygenation saturation was defined as (<92%) using pulse oximetry or a partial pressure of carbon dioxide (PCO2) of (>45 mmHg) using arterial blood gas. Secondary outcomes included need for tracheostomy, mortality and abbreviated injury scores (AIS). Patient demographics, transportation method and duration, traumatic mechanism, trauma severity (ISS and abbreviated injury scores (AIS)), admission vital signs (heart rate, respiratory rate, systolic and diastolic blood pressure and oxygen saturation), Glasgow Coma Score (GCS), 24 h and overall mortality, frequency and type of prehospital airway complications, and number of prehospital airway attempts, durations of intensive care, mechanical ventilation and overall hospital stay were abstracted from the electronic record.

1.4. Statistical analyses

Summary statistical and univariate analyses were performed. Continuous variables were described using means with standard deviations (SD) if normally distributed and medians with interquartile ranges [IQR] for non-normally distributed data. Two-tailed t-tests were performed between prehospital airway groups (supraglottic rescue airway versus BVM with subsequent inpatient ETI). In order to assess which factors were associated with an increased need for surgical definitive airway (open tracheostomy), logistic nominal regression was applied to statistically significant and clinically important variables. Categorical variables were summarized as proportions, and differences were evaluated using chi-square analysis. Statistical inferences were based on 2-tailed tests with significance set at $P < 0.05$. All patients meeting inclusion criteria were included in the analysis; a priori power analysis was not performed owing to lack of data to suggest an appropriate effect size for the primary outcome of tracheostomy. Data were analyzed with JMP (SAS Institute, Inc. Cary NC). We utilized GraphPad Prism (GraphPad Software, Inc. La Jolla CA) for all visual graphics.

2. Results

2.1. Patient characteristics

The study population consisted of 90 patients with multisystem trauma. Of these, 17 patients received prehospital supraglottic rescue airway insertion and 73 BVM with subsequent inpatient ETI. Inadequate oxygenation and ventilation were demonstrated more frequently in patients that required supraglottic rescue airway (75%) compared to BVM (41%), $p = 0.01$. Table 1 presents patient demographics, admission vital signs, and measures of trauma severity between the supraglottic rescue airway and BVM groups. Sixty percent of patients were male. Between prehospital airway groups, patients that received a supraglottic rescue airway demonstrated increased head AIS scores compared to those receiving BVM (median [IQR]: 5 [4-5] versus 2 [0–4]. $p = 0.001$). Similarly, facial AIS scores were increased in patients receiving supraglottic rescue airways (median [IQR]: 1 [0–2]) compared to those with BVM (0 [0–0]), $p = 0.03$). Finally, patients that received BVM demonstrated increased rates of tachycardia compared to those managed with prehospital supraglottic rescue airways ($p = 0.01$). There were no significant differences between prehospital airway groups for patient sex, age, blunt traumatic mechanism, transport duration, cervical AIS, oxygen saturation at admission, respiratory rate, systolic or diastolic blood pressure.

a. *Prehospital airway outcomes*

Among the 17 patients, the indications for supraglottic rescue airway were multiple failed intubation attempts ($n = 12$) and multiple failed attempts with poor visualization ($n = 5$). Two cases of craniofacial trauma and three cases oropharyngeal trauma specifically affected airway visualization and thus prevented the successful placement of an endotracheal tube, leading to the insertion of a supraglottic airway device. In patients that received a prehospital supraglottic rescue airway, the overall median number of prehospital attempts at endotracheal intubation was 2 [1-3]. There was a significant increase in the median number of prehospital attempts at endotracheal intubation in patients who received surgical tracheostomy compared to endotracheal tube intubation (3 versus 2, $p = 0.01$). Conversely, no patient receiving BVM ($n = 73$) had an attempt at ETI; none of these patients experienced a prehospital airway related complication. At admission to the trauma resuscitation bay, the indications for ETI were copious vomiting in 3 patients and decreased Glasgow coma score (<8) in the remaining 70 patients.

2.2. Definitive airway and overall outcomes

After prehospital transport, all patients were evaluated by a multidisciplinary trauma team in the resuscitation bay per our institutional protocol (Fig. 1). The rate of tracheostomy was increased in patients with prehospital supraglottic rescue airway compared to those with BVM and inpatient ETI (31% versus 8%, $p = 0.02$). The patients that required tracheostomy after BVM and inpatient ETI ($n = 3$) were because of prolonged ventilator requirements. The twenty-four hour mortality was increased in patients with supraglottic rescue airways compared to BVM (38% versus 10.8%, $p = 0.01$). The overall mortality rate was dramatically increased in patients receiving prehospital supraglottic rescue airway (75%) compared to BVM (14%) $p = 0.0001$, Table 2. The causes of mortality between prehospital airway groups are outlined in Table 3. There were three cases of subglottic narrowing diagnosed via laryngoscopy in patients that received BVM and subsequent inpatient ETI. There