ARTICLE IN PRESS
YAJEM-56973; No of Pages 6
American Journal of Emergency Medicine xxx (2017) xxx–xxx
Contents lists available at ScienceDirect
American Journal of Emergency Medicine
journal homepage: www.elsevier.com/locate/ajem

Definitive airway management after pre-hospital supraglottic airway insertion: Outcomes and a management algorithm for trauma patients☆

Matthew C. Hernandez, MD [a,*], Johnathon M. Aho, MD [a], Martin D. Zielinski, MD [a], Scott P. Zietlow, MD [a], Brian D. Kim, MD [a], David S. Morris, MD [b]

[a] Division of Trauma Critical Care and General Surgery, Department of Surgery, Mayo Clinic, Rochester, MN, USA
[b] Division of General Surgery, Trauma, and Critical Care, Intermountain Medical Center, Murray, UT, USA

ARTICLE INFO

Article history:
Received 27 June 2017
Received in revised form 9 September 2017
Accepted 14 September 2017
Available online xxxx

Keywords:
Prehospital
Airway
Supraglottic airway
Trauma
Tracheostomy

ABSTRACT

Background: Prehospital airway management increasingly involves supraglottic airway insertion and a paucity of data evaluates outcomes in trauma populations. We aim to describe definitive airway management in traumatically injured patients who necessitated prehospital supraglottic airway insertion.
Methods: We performed a single institution retrospective review of multisystem injured patients (≥15 years) that received prehospital supraglottic airway insertion during 2009 to 2016. Baseline demographics, number and type of: supraglottic airway insertion attempts, definitive airway and complications were recorded. Primary outcome was need for tracheostomy. Univariate and multivariable statistics were performed.
Results: 56 patients met inclusion criteria and were reviewed, 78% were male. Median age [IQR] was 36 [24–56] years. Injuries comprised blunt (94%), penetrating (4%) and burns (2%). Median ISS was 26 [22–41]. Median number of prehospital endotracheal intubation (PETI) attempts was 2 [1-3]. Definitive airway management included: (n = 20, 36%, tracheostomy), (n = 10, 18%, direct laryngoscopy), (n = 6, 11%, bougie), (n = 9, 15%, Glidescope), (n = 11, 20%, bronchoscopic assistance). 24-hour mortality was 41%. Increasing number of PETI was associated with increasing facial injury. On regression, increasing cervical and facial injury patterns as well as number of PETI were associated with definitive airway control via surgical tracheostomy.
Conclusions: After supraglottic airway insertion, operative or non-operative approaches can be utilized to obtain a definitive airway. Patients with increased craniofacial injuries have an increased risk for airway complications and need for tracheostomy. We used these factors to generate an evidence based algorithm that requires prospective validation.
Level of evidence: Level IV – Retrospective study.
Study type: Retrospective single institution study.

1. Introduction

A functional and patent airway during prehospital resuscitation is a critical consideration of trauma resuscitation [1]. Several risk factors confound prehospital airway control such as obesity and craniofacial trauma [2]. Supraglottic devices may be utilized for the difficult airway [1,3-5]. After supraglottic device insertion, methods to secure a definitive airway include direct laryngoscopy, blind tube exchange or fiberoptic guidance [6]. In cardiac arrest, supraglottic airway exchange may not be urgent as the primary focus is restoration of spontaneous circulation [7]. Conversely, the trauma resuscitation focuses on constant airway assessment to gauge patency and adequate ventilation. This is the unique difference; maintenance of airway control and prevention of dysoxia while systematically triaging injury care by severity whereas medical resuscitations aim to restore and maintain cardiac flow.

In the prehospital setting, supraglottic devices provide initial airway control with ease of insertion [8-10]. These advancements come at the expense of potential complications. Morbidity such as gastric distension, tube malposition and oropharyngeal edema resulting abrupt airway occlusion can occur [5,11-15]. Management algorithms exist to secure a definitive airway after supraglottic device insertion; however, these recommendations are from variable populations [16-19]. For trauma patients necessitating prehospital supraglottic airways, there is a

☆ Author contribution: Study design was developed by Matthew Hernandez, Johnathon Aho, David Morris, and Martin Zielinski. Data generation was performed by Matthew Hernandez. Data analysis and interpretation was performed by Matthew Hernandez, Johnathon Aho, Martin Zielinski, Scott Zietlow, Brian Kim, and David Morris. Manuscript writing was performed by Matthew Hernandez, Johnathon Aho, Scott Zietlow, Brian Kim, David Morris and Martin Zielinski.

* Corresponding author at: Division of Trauma Critical Care and General Surgery, Department of Surgery, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA.
E-mail addresses: Hernandez.matthew@mayo.edu (M.C. Hernandez), aho.johnathon@mayo.edu (J.M. Aho), Zielinski.martin@mayo.edu (M.D. Zielinski), kim.brian@mayo.edu (B.D. Kim), dave.morris2@imail.org (D.S. Morris).

http://dx.doi.org/10.1016/j.ajem.2017.09.028
0735-6757/

lack of evidence to adequately address definitive airway management. Therefore, we aimed to determine which definitive airway techniques were utilized after prehospital supraglottic device insertion in multisystem injured patients hypothesizing that patients with increased prehospital airway complications and craniofacial injury patterns would require advanced airway control, including surgical tracheostomy.

2. Methods

2.1. Patient cohort

From 2009 to 2016, we performed a single center retrospective study examining patients >15 years old with multisystem trauma defined as an Injury Severity Score of ≥9 that necessitated prehospital insertion of a supraglottic airway (patients receiving only a King Airway Device, King LT-D, Noblesville, IN). Patients were identified from the Mayo Clinic Trauma Center registry. Institutional review board approval was obtained prior to data review. Patients that refused research consent, received prehospital endotracheal tube intubation (PETI), were pregnant, or without multisystem trauma were excluded.

2.2. Prehospital airway institutional protocol

Patients were transported by a critical care trained rotor wing team or ground transport. Injured patients that require advanced prehospital airway management meet criteria for our highest level trauma activation, which includes Emergency Medicine, Surgery, and Anesthesia providers to be present at patient arrival. Each prehospital airway intervention at our facility is reviewed in detail by the directors of Medical Transportation, Emergency Medicine, Trauma Surgery, and Anesthesia divisions. A prehospital advanced airway control algorithm (Fig. 1) has been defined and implemented by this group to standardize difficult airway management in the prehospital setting. This algorithm is designed for use after clearly defined "failure" of standard prehospital endotracheal intubation (PETI) attempts and after non-invasive ventilation is determined to be inadequate.

2.3. Outcomes and predictors

The primary outcome for this study was need for tracheostomy. If a tracheostomy was not performed and instead an endotracheal tube exchange (ETT) was performed, the method of ETT was recorded (direct laryngoscopy, bougie, Glidescope, bronchoscopic assistance). 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 PETI, and durations of intensive care, mechanical ventilation or overall hospital stay were abstracted from the electronic record. Mortality was defined according to definitions reported previously [20].

2.4. 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 inter-quartile ranges [IQR] for non-normally distributed data and two tailed *t*-tests were performed between definitive airway techniques, endotracheal tube exchange (ETT) versus surgical tracheostomy. Categorical variables were summarized as proportions, and differences were evaluated using chi-square analysis. All p-values were considered significant at $p < 0.05$. Clinical and statistically significant variables were evaluated to assess for risk factors for 24-h mortality using nominal logistic regression with 95% confidence intervals (CI). Data was analyzed with JMP (SAS Institute, Inc. Cary NC). We utilized GraphPad Prism (GraphPad Software, Inc. La Jolla CA) for all visual graphics.

3. Results

3.1. Baseline demographics

The study cohort consisted of 56 patients with multisystem trauma and supraglottic airway insertion. The median [IQR] ISS was 26 [22–41] and 78% of patients were male. The mean (±SD) age was 39.6 (±21.2) years. Most patients (72%) were transported via rotor wing and median [IQR] transport time was 20 [13−33] minutes. Mean (±SD) body mass index (BMI) was 29.2 (±6.6). The median [IQR] head, neck and facial abbreviated injury scores (AIS) were: head 4 [3-5], neck 2 [0–3], face 1 [0–2] respectively, Table 1. Mechanisms of injury included blunt (n = 53, 94%), penetrating (n = 2, 4%), and burn (n = 1, 2%).

3.2. Prehospital airway characteristics

In the prehospital setting, supraglottic device indications included failed PETI (n = 56, 100%). The median [IQR] attempts at PETI were 2 [2–3]. The number of failed PETI attempts increased in patients with increased craniofacial injury patterns Fig. 2. At arrival, all patients had a patent and functional airway provided by the supraglottic device. During prehospital resuscitation, there were 35 (63%) complications including significant laryngeal or oropharyngeal edema preventing PETI (n = 22, 63%) and supraglottic airway dislodgement (n = 13, 37%).

3.3. In hospital outcomes and definitive airway management

Techniques for in hospital definitive airway included ETT (n = 36; 64%) or surgical tracheostomy (n = 20; 36%). For patients managed with ETT, 50% (n = 18) were performed in the emergency room and 50% (n = 18) were performed in the operating room. Table 2 compares outcomes and secondary predictors by definitive airway and this demonstrates the association of increased craniofacial injury patterns with a need for surgical tracheostomy. In patients who required definitive airway with a surgical tracheostomy, compared to ETT, there was an increased median facial AIS (4 [3-4] versus 1 [0–2], $p < 0.0001$). There was no statistically significant difference in median head AIS (4 [2–5] versus 4 [2–5]) injury severity but there was an approach to statistical significance and likely clinical significance in patients with increased median cervical AIS (2 [0–3] versus 1 [0–2], $p = 0.08$). Multivariable analysis demonstrated that the following factors were independently associated with need for surgical tracheostomy compared to ETT in patients with a prehospital supraglottic rescue airway: Facial AIS ≥3, cervical AIS ≥ 3, and number of PETI attempts, Table 3.

During definitive airway management (open tracheostomy or endotracheal tube exchange (ETT)), the median [IQR] oxygen saturation nadir was significantly lower in patients that received ETT compared to open tracheostomy, (84% [75–89] versus 92% [88–94], $p = 0.007$). This difference disappeared within 10 min of definitive airway management completion (99 [96–99] versus 99 [96–100], $p = 0.8$). There were no long-term complications from surgical tracheostomy or ETT during follow up, median 13 [1–37] months.

There were 23 patients that expired. Causes for mortality included myocardial infarction (n = 3), pulmonary contusion (n = 4), and tension pneumothorax (n = 3), traumatic brain injury (n = 5), and hemorrhagic shock (n = 8). No deaths were related to inpatient airway complications. There was less overall mortality in those receiving tracheostomy compared to those undergoing ETT (n = 8, (24%) versus n = 27, (77%), $p = 0.01$). With respect to 24-hour mortality, a more pronounced difference existed between patients undergoing tracheostomy compared to ETT (n = 3, (13%) versus n = 20, (87%), $p = 0.004$).

Please cite this article as: Hernandez MC, et al, Definitive airway management after pre-hospital supraglottic airway insertion: Outcomes and a management algorithm for trauma pati..., American Journal of Emergency Medicine (2017), http://dx.doi.org/10.1016/j.ajem.2017.09.028