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Review Articles

Clinical considerations for blunt laryngotracheal trauma in children☆,☆☆

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ABSTRACT

Objective: Systematic review of blunt pediatric laryngeal and tracheal trauma and development of proposed evaluation and management strategy.
Study design: Systematic review and proposed clinical consideration algorithm.
Data sources: PubMed, EMBASE, Web of Science, and Cochrane Central Register of Controlled Trials.
Review methods: A medical librarian was utilized.
Results: 329 titles and abstracts were identified, and 50 reports were included. A total of 66 children were identified, with a majority of males (76.1%). Average age was 9.5 ± 4.4 years [range 2–17]. CT was employed in 66.7% of cases. False negative CT occurred in 29.5% of cases. Treatment consisted of observation (9.1%), endoscopy alone (31.8%), endoscopic repair (7.6%), and open neck exploration with repair/open reduction internal fixation (ORIF) (51.5%). Tracheotomy was utilized in 33.3% of the cases. Mortality was rare, with only one (1.5%) reported and occurred within one hour after presentation.
Conclusions: Significant deviation and variation from recommended previously proposed management algorithms exists in reported cases. Awareness of the natural clinical history, potential for severe morbidity or mortality, and associated complications are extremely important. CT and fiberoptic, bedside laryngoscopy may not play a significant role but may add to clinical evaluation prior to operative intervention. If employed, care must be taken to not create an unstable clinical scenario. Operative endoscopy is recommended in cases with positive physical examination findings, and treatment tailored to extent of injury.
Level of evidence: IV.
Type of study: Systematic review.

Traumatic injuries of the larynx and trachea in children have been noted to be rare but can be life-threatening [1]. On average, less than about 20 of these cases were encountered per year in the United States between 2002 and 2006, with blunt-force trauma being the etiology in most cases (82.8%). Most children involved are around 12 years of age, and there is a significant associated mortality rate of 8.7% [2]. Of note, it is clinically concerning that there is an increasing incidence of these types of injuries [3]. Radiographic findings associated with this pattern of traumatic injury include normal results, fracture of the cartilaginous laryngotracheal framework, edema of the endolaryngeal soft tissues, pneumomediastinum, subcutaneous emphysema, and pneumorachis [4].

Schaefer, later refined by Fuhrman et al., put together a classification system and management recommendations for blunt laryngotracheal injuries that is still clinically referred to today. However, their experience spanned all age ranges [5–7] (Table 1). Clinical evaluation and management considerations in children may differ, as children with laryngotracheal trauma may develop respiratory symptoms much more quickly or be more severely affected given the smaller dimensions of the pediatric airway [8]. This management paradigm includes more reliance on computed tomography (CT) imaging. Whereas in children, CT may not be as helpful in making a diagnosis or affect decisions regarding treatment [9]. CT imaging may provide false negative findings, even in cases of significant airway injuries in children, and may provide a false sense of security. Delayed onset of severe symptoms and impending airway compromise may result [10]. Bedside laryngoscopy is less likely to be well tolerated by children. Lastly, Fuhrman et al. advocate for immediate tracheotomy for group 2 injuries, but some blunt laryngeal traumatic injuries in children that fit into group 2 blunt laryngeal trauma injury patterns, may safely be managed without tracheostomy [10,11].

Presentation of blunt laryngeal and tracheal injuries in children can be subtle and may mimic other common pediatric respiratory issues. Diagnosis may be delayed, which highlights the importance of clinical history and guideline development for airway management for blunt

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Table 1
Fuhrman blunt laryngeal trauma classification and management protocol, 1982 and 1990.

Class of injury	Findings	Management recommended
1	Minor endolaryngeal hematoma without detectable fracture	Indirect laryngoscopy (IL) or flexible nasopharyngoscopy (FN) in the emergency department (ED) followed by CT scan. Close observation with serial examination as necessary
2	Edema, hematoma, minor mucosal disruption without exposed cartilage, nondisplaced fractures noted on CT scan	IL or FN in the ED followed by immediate tracheotomy. Direct laryngoscopy and esophagoscopy. CT scan of larynx
3	Massive edema, mucosal tears, exposed cartilage, cord immobility	IL or FN in the ED. Immediate tracheotomy. Direct laryngoscopy and esophagoscopy. CT scan of larynx
4	As group 3, with more than two fracture lines or massive trauma to the laryngeal mucosa	Same as group 3
5	Complete laryngotracheal separation	Immediate tracheotomy, direct laryngoscopy and esophagoscopy followed by exploration

laryngeal injuries in children [12–14]. Prior reports of blunt laryngotracheal trauma in children are generally classified according to systems that are generalized from experiences with patients from all age ranges. We sought to perform a systematic review of the literature to help guide diagnostic and treatment recommendations specifically for the pediatric population, and investigate if principles of prior management algorithms have been employed.

1. Methods

Using a medical librarian's services, we performed a query of the PubMed, EMBASE, Web of Science, and Cochrane databases for studies examining reports of blunt laryngeal or tracheal injuries in children (Appendix 1). Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and checklist were used, and given the available published literature, a systematic overview was utilized [15]. Titles and abstracts were reviewed by two independent reviewers for appropriate inclusion criteria including: (1) original study reporting individual patient outcomes and clinical courses; (2) age 17 years or less; (3) airway injuries only involving and limited to the larynx and/or trachea; and (4) and injuries caused by blunt trauma. Upper limits for age cutoffs for descriptions of blunt trauma in children range vary, as teenagers may develop more mature laryngotracheal pathophysiology and functional mature airway status, more similar to adults [16]. We opted to use the cutoff of 17 years of age.

Studies published from the years after 1980 in English were considered. Exclusion criteria included: (1) aggregated data from registries and databases; (2) postintubation related injuries; (3) mechanism of injury resulting from non-blunt trauma or not specified; (4) case reports or series that did not include initial management; (5) published abstracts without sufficient clinical information; and (6) publications prior to 1980. One of the first papers describing experience and approach to the patient with blunt laryngeal trauma that is most often referenced was first published in 1980 [17]. Thus, we decided to examine all studies after this time given that the authors may have been familiar with those principles and clinical considerations. Also, studies that did not obviously fulfill inclusion criteria, including review articles, basic science studies, experimental laboratory investigations on cadavers, as well as unpublished abstracts and expert opinion were also excluded. The remaining articles underwent full-length review and data were extracted for individual-level analysis (Fig. 1). References were reviewed for further potentially applicable studies. No contact with the authors was performed given the retrospective nature of the reports. Quality assessment was also performed for each of the included studies reporting adverse events according to the tool developed by Chou and Helfand for Agency for Healthcare Research and Quality (AHRQ) systematic review (Appendix 2).

Airway stability was determined by the case description or if patient did not have respiratory symptoms immediately. Unstable airways were defined as any description of respiratory distress, arrival to hospital intubated in the field, or need for emergent intubation upon presentation. To determine if case management and outcomes described differed from previously presented management, we compared them to protocols by Schaefer and Fuhrman [5,7], as well as Gold et al. [18]

Statistical analysis was performed using GraphPad Prism software (La Jolla, CA). Univariate analysis examining association with the following variables: age, tracheostomy placement, type of injury, presence of subcutaneous emphysema, gender, mechanism of injury, and type of treatment was performed using a Fisher's exact or chi-square test, depending on the analysis. Statistical significance was set a $p < 0.05$ and reported as two-tailed, unless otherwise specified; 95% confidence interval (CI) was also reported when appropriate. Age categories were broken down by child developmental age ranges: toddler (ages 2–5), child (6–12), and adolescents (13–17). Mechanisms of injuries were categorized as: isolated fall, bike/scooter, sports-related, or powered vehicle involvement. Types of injuries were characterized as: none, isolated endolaryngeal, mucosal (involving the posterior tracheal wall), or laryngotracheal cartilaginous framework injuries (including fractures of laryngeal skeleton and cricotracheal separation). Treatments were organized into: observation, endoscopy alone, endoscopic repair, open neck exploration with repair and/or open reduction and internal fixation (ORIF).

2. Results

The results of our medical librarian query (Appendix 1) revealed 329 titles and abstracts. 87 full-text articles were reviewed for eligibility, and 38 were excluded. One additional article was identified for inclusion,

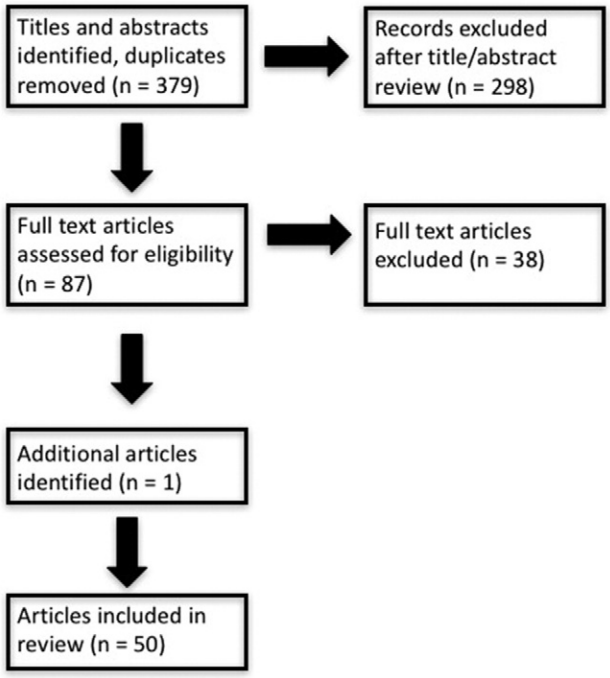

Fig. 1. PRISMA flow diagram for systematic review.