

Oral, Jaw, and Neck Injury in Infants and Children

From Abusive Trauma or Intubation?

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Objectives: The objective of this study was to identify the incidence of oral, jaw, and neck injury secondary to endotracheal intubation in young children.

Methods: This prospective observational study was conducted in the pediatric intensive care unit at a level 1 trauma center. From October 1998 to January 1999 and November 2007 to April 2008, all intubated patients younger than 3 years with no prior oral procedures were examined within 24 hours of intubation. A standardized form was used to record injuries. Separately, medical records were reviewed for prior injuries. Chi-square/Fisher exact test was used for statistical analysis.

Results: Of 105 patients included in the study, 12 had oral, jaw, or neck injury. One patient had a hard palate injury from a pen cap in his mouth during a seizure. Another broke a tooth biting the laryngoscope blade (the only injury directly attributable to intubation). The remaining 10 patients were determined to be those who experienced abusive trauma. The overall incidence of injury directly from intubation was 0.9%. Oral, jaw, and neck injuries were all significantly associated with abusive trauma ($P < 0.001$). Eleven patients had difficult intubations: 9 had no injuries, 1 experienced abusive trauma and the second was the patient who broke his tooth during intubation.

Conclusions: Oral, jaw, or neck injury in young children is rarely caused by endotracheal intubation, regardless of difficulty during the procedure.

Key Words: intubation, oral, injury, child abuse

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Endotracheal intubation has been used successfully since the early 20th century¹ and has been an integral part of cardiopulmonary resuscitation (CPR) since its inception in the 1950s to 1960s.² There have been reports of complications from CPR such as skeletal fractures, lacerated internal organs, hemothorax, pulmonary barotrauma, and upper airway complications reported in the adult literature.³ Injuries in infants and children such as rib fractures or retinal hemorrhages are sometimes attributed to resuscitative efforts, but studies have shown that these injuries are rarely caused by resuscitation.^{4–6} Complications from endotracheal intubation include injuries to the larynx, pharynx, esophagus, trachea, jaw, and nose.⁷ Dental injury is the most common adult injury.⁷ Intraoral injuries

have also been attributed to endotracheal intubation in children, but although some pediatric studies describe intubation injury to the trachea and larynx, there is no description or studies involving the incidence of these types of intubation injuries in children.^{8–11} Usually, these types of injuries are trivial, but if present in the setting of endotracheal intubation, they could distract medical personnel from recognizing injuries as being abusive.^{12,13} Our goals in this study were to identify the incidence of oral, jaw, and neck injury secondary to intubation in children and to determine whether these injuries occurred during the intubation.

METHODS

This was a prospective observational study conducted in the pediatric intensive care unit (PICU) of Loma Linda University Children's Hospital from November 2007 to April 2008. The institutional review board approved the study and waived written consent because both the physical examination (standard care) and photographs (photographic consent) were already consented through the conditions of treatment form that all parents sign upon admission to the institution. We included children who were younger than 3 years, had no prior oral surgery or procedures, and were intubated within the previous 24 hours. All intubated patients meeting inclusion criteria were enrolled sequentially. Injury was not an inclusion criterion. Pediatric intensive care unit physicians and/or forensic pediatricians meticulously examined each patient within 24 hours of intubation. The bedside PICU nurse or respiratory therapist held the endotracheal tube securely while a thorough examination of the lips, teeth/gums, frena, tongue, jaw line, or neck was performed around the endotracheal tube to look for any evidence of trauma or injury. The tape securing the endotracheal tube was not removed, and a tongue blade or an examiner's finger was used to carefully manipulate the endotracheal tube. Specific evidence of injury included lacerations, contusions, petechiae, erythema, and broken teeth. A standardized form was used to record any abnormalities. If any evidence of injury was found, photographs and a complete description of the injury were obtained. The setting where the injury occurred was documented. The emergency department, transport, and PICU histories were reviewed for evidence of any prior injury, either accidental or inflicted. One physician conducted the medical record reviews for all patients from prehospital to discharge. We also included 46 patients from a pilot study conducted in the same unit with identical methodology from October 1998 to January 1999.

Chi-square/Fisher exact test was used to determine whether oral-jaw-neck injuries were statistically related to the endotracheal intubation, the personnel performing the procedure, and/or the setting where it was performed. Statistical analysis was completed using SPSS version 17, (SPSS, Chicago, Ill), and statistical significance was defined as $P < 0.05$.

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RESULTS

We examined 110 children younger than 3 years in our PICU who had been recently intubated in the 2 separate cohorts: October 1998 through January 1999 and November 2007 through April 2008. The 2 cohorts were analyzed separately and together with no significant differences identified; therefore, both data sets are reported together. One hundred five patients met the inclusion criteria. Five patients were excluded: 4 patients were examined after 24 hours of intubation, and 1 patient had an esophagogastroduodenoscopy before intubation. The first cohort consisted of 46 patients with a median age of 8.5 months (range, 0.5–36 months). The second cohort consisted of 59 patients with a median age of 4 months (range, 0.5–30 months). The children in our population were mostly male (59%). The ethnicities were predominantly Hispanic (49%) and white (30%), which reflects the demographics in our area. The reasons for admission varied from pneumonia to seizures. The most common reasons for intubation were respiratory distress (23%) and respiratory failure (34%). Other reasons included surgical procedures, seizures, and head trauma. The most frequent setting for intubation was the emergency department and the most common personnel performing the intubations were emergency department physicians (Table 1). There were 75 of the 105 patients (71%) who were intubated outside our PICU.

On physical examination, 12 patients were found to have oral, jaw, or neck injuries. One patient had an explainable hard palate injury from a pen cap in his mouth during a seizure episode. Another patient broke a tooth when he bit the laryngoscope blade during an unsuccessful pre-hospital intubation attempt. This was the only patient in our cohort where the observed injury was directly attributable to endotracheal intubation (0.9%). The other 10 patients were found to have abusive injury (83%). The patients were identified as those who have abusive injury only after comprehensive medical and psychosocial investigations. Specific injuries recorded at the time of intubation examinations were damage to the lips, tongue, mouth, jaw, and neck. All these injuries were strongly associated with abusive trauma ($P < 0.001$) (Fig. 1). Lip and tongue

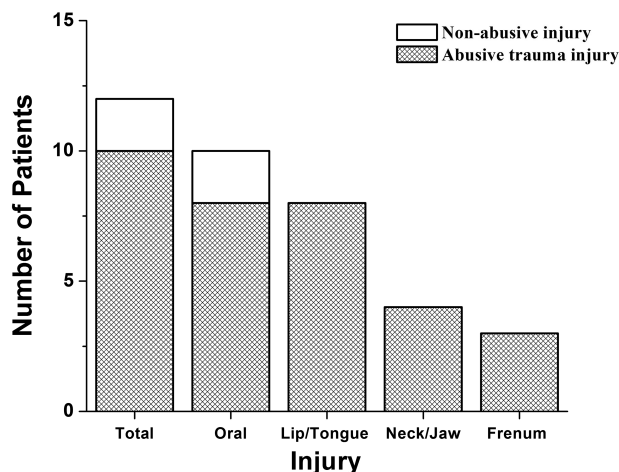


FIGURE 1. The number of the patients and cases of abusive trauma per injury type. The numbers do not total 12 because of overlapping injuries. Oral injuries included all lip/tongue and frenum injuries.

injuries included lacerations, bruising, and swelling. Oral injuries included bruising, lacerations, and frena injuries. Jaw and neck injuries included bruising and petechiae.

There were no significant associations found between the oral-jaw-neck injuries and the setting of the intubation or the personnel performing the intubation. However, the only injury directly attributable to endotracheal intubation occurred in the pre-hospital setting. Cases of the 11 patients were documented on the standardized form to have had difficult intubations or had multiple attempts at intubation. A difficult intubation was defined by the intubating or admitting physician who documented it on the form. Chart reviews on each patient revealed that 10 had multiple attempts at intubation. The case of the other one was documented to have difficult anatomy but needed only 1 attempt. Nine of the 11 patients (82%) had no injuries. One of the 2 patients with injuries was discovered to have experienced abusive trauma. There was bruising on the jaw in addition to multiple bruises found on the trunk and extremities. The patient also had abusive head trauma with intracranial bleeding and retinal hemorrhages. The remaining patient with an injury was the same child who had a broken tooth.

To help secure the endotracheal tube, the bedside PICU nurse or respiratory therapist assisted in the physical examinations by holding the endotracheal tube in place. Fifteen patients (14%) were examined after they were extubated. There were no accidental extubations.

The most common primary and associated injuries documented from the chart review were intracranial hemorrhage, bruising, oral injuries, and fractures. These were also strongly associated with abusive trauma ($P \leq 0.002$) (Table 2). Bruises were found in multiple areas (head, trunk, abdomen, and lower extremities). Eye injuries included subconjunctival hemorrhage and orbital bruising/swelling. Retinal hemorrhages were classified under internal injuries. Ear injuries included bruising and abrasions. Intracranial hemorrhage included subdural, subarachnoid, and epidural bleeds. Fractures were mostly found in the skull.

Overall, 14 patients were determined to have experienced abusive trauma as determined through comprehensive medical and psychosocial investigations. In all patients, this included a multidisciplinary team evaluation including forensic pediatricians, pediatric radiologists, ophthalmologists, and social work.

TABLE 1. Number of Intubations and Oral-Jaw-Neck Injuries by Setting/Personnel

	No. Intubations, n (%)	No. Oral-Jaw-Neck Injuries	No. Injuries from Intubation, n
Setting			
Emergency department	47 (45)	7	0
PICU	32 (30)	2	0
Scene of injury	5 (5)	2	1
Operating room	17 (16)	1	0
Pediatric ward	4 (4)	0	0
Personnel			
Emergency department physician	42 (40)	7	0
Pediatrician/intensivist	37 (35)	2	0
Paramedic	5 (5)	2	1
Anesthesiologist	18 (17)	1	0
Unknown/other	3 (3)	0	0

TABLE 2. List of Injuries Per Patient

Age, mo	Difficult Intubation	Personnel Performing Intubation	Abused	Mouth/Jaw/Neck Injury	Soft Tissue/ Superficial Injury	Internal Injury	Fractures
4	No	Pediatric physician	Yes	Small bruise to the angle of the right jaw	Bilateral ear bruising	Subdural hematoma, subarachnoid hemorrhage	None
17	No	ED physician	Yes	Swollen lips; bruised, torn upper frenulum; tongue bruised; bloody teeth	Multiple human bites, bruised eyelids	None	Skull
30	No	ED physician	Yes	Bite mark to the tongue	Scrotum, buttock bruising; belt mark patterns on buttocks and loop marks to the thigh; left ear abrasion; right corneal abrasion with chemosis	None	None
2.5	No	ED physician	Yes	Upper lip petechiae; 2-mm laceration to the corner of the right side of the mouth	None	Bilateral retinal hemorrhage; subarachnoid hemorrhage; cerebral edema	None
5	No	ED physician	Yes	Bruise at left angle of mouth; swollen upper lip; lower lip petechiae	Bite marks on the shoulder, abdomen, right flank and feet; bilateral eyelid bruising	Large bilateral subdural/subgaleal hematoma; diffuse bilateral retinal hemorrhages	Left ulnar
9	No	ED physician	Yes	Pinpoint contusion on the left side of the neck; petechiae on the right side of the neck; laceration on the tip of the left side of the tongue	Bruising behind the right ear; small petechiae on the right ear	Left subdural hemorrhage; subarachnoid hemorrhage; small intraparenchymal hemorrhage on the right temporal lobe; bilateral retinal hemorrhage; bruising to the calf, shoulder, and buttocks	Parietal, temporal, and occipital skull
23	No	Paramedic	Yes	Multiple bruises and petechiae on the jaw line; left lower lip laceration and bruising; erythematous tongue	Ear bruising	Right subdural hemorrhage; bilateral retinal hemorrhage; bruising on the head, face, chest, and calf	None
1	Yes; needed 3 attempts	Pediatric physician	Yes	Chin bruising	Bruising on the left eyelid, cheekbone, lower legs, and buttocks	Bilateral subdural hematomas; retinal hemorrhages	Bilateral posterior ribs; midshaft clavicular; right acromion
21	No	Anesthesiologist	Yes	Bruising on the lower lip, healed frenum scar	Left eye subconjunctival hemorrhage; cigarette burns to the chest, labia, anus; abdominal bruising	None	None
5	No	ED physician	Yes	Lower frenum tear; lip abrasion	None	None	Occipital, upper humerus
3.5	No	ED physician	Yes	None	Bruising on the right side of the forehead	Bilateral subdural hemorrhages; retinal hemorrhages to the left eye	None

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TABLE 2. (Continued)

Age, mo	Difficult Intubation	Personnel Performing Intubation	Abused	Mouth/Jaw/Neck Injury	Soft Tissue/ Superficial Injury	Internal Injury	Fractures
4	No	ED physician	Yes	None	None	Epidural hematoma	Frontal skull
11	Yes; needed 2 attempts	ED physician	Yes	None	None	Bilateral subdural hemorrhages; bilateral retinal hemorrhages	Right parietal skull
3	No	Pediatric physician	Yes	None	None	Subdural, subarachnoid, intraventricular hemorrhages; bilateral retinal hemorrhages	None
24	No	Paramedic	No	Linear abrasion to the hard palate	None	None	None
30	Yes; needed 2 attempts	ED physician	No	Broken tooth	Facial petechiae	None	None

Includes all patients with oral, jaw, and neck injuries and all patients found to experience abuse.

ED, emergency department.

All patients received the standard of care regarding their forensics evaluation including skeletal surveys, intracranial imaging, fundoscopic examinations, and other tests as deemed appropriate. Ten patients who experienced abuse (as described previously) had oral, jaw, and/or neck injury and 4 did not. All 4 patients who experienced abuse without oral-jaw-neck injury were younger than 1 year and all had head injuries that led to injuries with intracranial bleeding. Three of the 4 patients had evidence of retinal hemorrhages. The 10 patients who had oral, jaw, or neck injuries had more evidence of repeated abuse including different colored bruises to multiple areas, bite marks, fractures, and cigarette burns.

DISCUSSION

To our knowledge, this is the first prospective study to specifically demonstrate that the incidence of oral, jaw, or neck injury directly from endotracheal intubation is low. Only 1 patient of the 105 displayed an injury directly attributable to endotracheal intubation. Therefore, any unwitnessed injury to the oral, jaw, or neck region should increase the suspicion for abusive trauma.

Our investigation shows that even difficult intubations or multiple intubation attempts are not well correlated with oral, jaw, or neck injury. Eighty-two percent of cases of the patients whom the physicians documented as having had difficult intubations or needing multiple intubation attempts did not have injuries, with 1 of the 2 injured patients having experienced abusive trauma with bruises on the jaw and trunk/extremities. There is little pediatric literature about acute iatrogenic intubation injury. An adult study by Newland et al¹⁴ of dental injury in 161,687 anesthetic cases showed that patients who were difficult to intubate had a higher risk for dental injury (approximately 20-fold increase). However, their overall incidence of dental injury was 0.05% (1/2073 cases); therefore, the incidence of injury even with difficult intubations was still low.

There are reports of iatrogenic oral injury from intubation and resuscitation.^{15–17} These reports did not state whether the injuries were directly witnessed. They also did not take into account the possibility of a preexisting injury. In 1992, Patel¹⁵ described 2 cases of iatrogenic oral injury in fatally injured

children. The first was a 6-month-old female who was “recovered under criminal circumstances from the river foreshore.” The patient had mouth-to-mouth resuscitation by police and emergency crews. An anesthesiologist who had trouble with the endotracheal intubation noted a frenum injury. The article did not state whether the injury was directly witnessed/caused by the anesthesiologist. It also did not take into account the possibility of a preexistent injury, which could be important because the father pleaded guilty to manslaughter. The second case was a 2-year-old male brought to the hospital “moribund,” with multiple bruises, cigarette burns, and fractures. He had mouth-to-mouth ventilation by the ambulance crew, and oral suction was performed to clear his airway. There was no clinical record of mucosal injury. On autopsy, examination of the mouth showed a superficial mucosal laceration approximating the upper lateral incisor and an intact frenum, in addition to multiple other injuries including bite marks, cigarette burns, and healed extremity fractures. Although these 2 cases were quoted as being evidence of non-abusive oral trauma,¹⁶ it would be difficult to say that the oral injuries were definitely caused by resuscitation when these injuries were not directly witnessed and there was other information conclusive of abusive trauma (1 father pleading guilty to manslaughter and 1 child with multiple injuries including cigarette burns and fractures).

A study by Price et al¹⁷ in 2000 of CPR-related injuries in children with homicidal blunt abdominal trauma noted infrequent lacerated/contused frena and tongues, but these findings were not discussed in detail, and neither were the timeliness of examinations nor how it was determined that the lacerated frena were results of endotracheal intubations. In contrast, our investigation documented physician examination within 24 hours of the intubation with controlled criteria for describing/reporting injuries and documented associated injuries or history that could indicate preexistent injury.

It is certainly possible to have iatrogenic injury from resuscitative efforts, but the findings of this study and the paucity of other evidence show how infrequent these incidents are. Bush et al,¹⁸ in 1996, described pediatric injuries from CPR. In this retrospective analysis of 211 patients where 81% were intubated, only 7% had CPR-related injuries, the most common being chest wall contusions/abrasions. None of these

patients were described as having any oral, jaw, or neck injuries. Brownstein et al,¹⁹ in 1996, retrospectively reviewed children aged 15 years or younger who were intubated in the pre-hospital setting. Of 269 intubated patients, only 2 had oral/dental trauma (0.7%). It was not clear how they determined the cause of the injury. In their 2000 study of pre-hospital pediatric intubations on survival and neurologic outcome, Gausche et al²⁰ demonstrated that only 2% (8/363) of pediatric patients who were intubated in the pre-hospital setting had evidence of oral/airway trauma. They did not elaborate the specific oral/airway injuries for their patients.

This study also demonstrates that specific injuries to the lips, tongue, mouth, jaw, and neck were all strongly associated with abusive trauma ($P < 0.001$). These findings confirm conclusions from prior studies showing that injuries to the mouth, neck, face, and head occur in a significant number of children who have been physically abused.^{16,21,22} Reports demonstrate the incidence of these injuries in abused children ranging from 50% to 75%.^{21,23–25} Further chart review showed that the most common documented injuries overall (intracranial hemorrhage, bruising, oral injuries, and fractures) were also highly associated with abusive injury ($P \leq 0.002$), confirming that these types of injuries are among the most common of all pediatric abusive trauma injuries.²²

Although our findings show that injuries to the lips, tongue, mouth, jaw, and neck were all strongly associated with abusive trauma, care must be taken not to designate any isolated injury as pathognomonic for child abuse. Maguire et al¹⁶ concluded, after a systematic literature review of torn frenum and intraoral injuries in children aged 0 to 18 years, that a torn labial frenum in isolation should not lead to a diagnosis of abuse. However, their study does emphasize the need for a full investigation when an unexplained torn labial frenum is discovered in a young child. Thackeray²⁶ presented case reports of 3 infants discharged home with frena tears who later returned with severe abusive head injury and similarly suggested that the presence of even isolated intraoral injury should warrant a thorough medical and psychosocial evaluation. In our study, all 14 patients were diagnosed as having experienced abusive trauma only after comprehensive medical and psychosocial workups were completed.

There are limitations in this study. It is a single-center investigation and the cohorts were separated by 10 years. The endotracheal tube and tape could have potentially limited the completeness of the oral examination, although each of the physicians felt they were able to get adequate views of the intraoral anatomy while the PICU nurse or respiratory therapist held the endotracheal tube securely. For the majority of the patients, the physicians completing the examination form were different from those performing the intubations because most were done outside of our PICU (71%). Therefore, it could be possible to have minor injuries noted immediately during or after the intubation that may not be obvious later on the physical examination (eg, pinched lips or gums that only bleed briefly), even if performed within 24 hours. There were also no documented examinations done before intubation. However, the vast majority (89%) of intubated patients having no evidence of injury supports the notion that endotracheal intubation is rarely associated with injury.

CONCLUSIONS

In summary, oral, jaw, or neck injuries in young children seem to be rarely caused by endotracheal intubation regardless of difficulty during the procedure or multiple attempts. Our findings imply that unexplained injuries to the mouth, jaw, or

neck in a child with critical illness are likely from abusive injury and not from endotracheal intubation.

Pre-hospital providers and emergency department physicians should document existing oral injuries noted before any intubation attempts. This could help future investigations rule out the intubation as a cause of oral, jaw, or neck injury.

Further studies are needed with personnel performing endotracheal intubations evaluating for and documenting any oral, jaw, or neck injuries before and immediately after the intubation. Additional studies including more children who were intubated in a pre-hospital setting may add useful data in this specific population.

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