WebLog Journal of Head and Neck Surgery

Systematic Review
Published: 05 Sep, 2026

Neonatal and Pediatric Head and Neck Trauma: A Comprehensive Review and Systematic Evidence Synthesis (1965–2026)

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WebLog Open Access Publications
Article ID : wjhns.2026.i0502
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Received Date: *23 Jul 2026*
Accepted Date: *03 Sep 2026*
Published Date: *05 Sep 2026*

Citation:
More AB, Govani PS, Khatri LK, Zaparackaite I, More BB, Singh SJ, et al. Neonatal and Pediatric Head and Neck Trauma: A Comprehensive Review and Systematic Evidence Synthesis (1965–2026). WebLog J Head Neck Surg. wjhns.2026.i0502. https://doi.org/10.5281/zenodo.22647033

Abstract

Background: Neonatal and pediatric head and neck trauma presents unique diagnostic and management challenges due to anatomical immaturity, age specific injury patterns, and evolving mechanisms of trauma. Early literature highlighted the vulnerability of the pediatric airway and craniofacial skeleton, while contemporary studies emphasise imaging-based evaluation and multidisciplinary care.

Objective: To synthesise historical and contemporary evidence on neonatal and pediatric head and neck trauma, with a focus on airway injury, craniofacial trauma, and penetrating neck injury.

Methods: A systematic review was conducted according to PRISMA 2020 guidelines. PubMed, Embase, Cochrane Library, Scopus, and Web of Science were searched from 1965-2026. Eligible studies described mechanisms, injury patterns, diagnostic modalities, or management strategies in children aged 0-18 years.

Results: Twenty-five high quality studies met inclusion criteria. Airway injury remains the most critical determinant of morbidity, consistent with foundational work from the 1970s and 1990s. Craniofacial fractures demonstrate age specific patterns influenced by skeletal development. Penetrating neck trauma requires zone-based assessment guided by haemodynamic stability, with CT angiography now central to evaluation. Across all domains, early airway control, structured assessment, and multidisciplinary coordination were associated with improved outcomes.

Conclusion: Pediatric head and neck trauma demands early recognition, systematic evaluation, and coordinated specialist involvement. Despite advances in imaging and airway management, gaps persist in early diagnosis and standardised care pathways. Future research should prioritise multicentre prospective studies, AI assisted imaging, and harmonised trauma protocols.

Keywords: Pediatric Trauma; Neonatal Airway; Craniofacial Injury; Penetrating Neck Trauma; Airway Management; Systematic Review

Introduction

Neonatal and pediatric head and neck trauma has been recognised as a distinct clinical entity for more than six decades. Guthrie's foundational work in 1965 first described the disproportionate vulnerability of children to airway and craniofacial injury due to anatomical immaturity, demonstrating that even low energy mechanisms may result in significant morbidity [1]. The development of structured trauma scoring systems in the 1970s, particularly the Injury Severity

Figure 1: Graphical Abstract.

Score by Baker *et al.*, provided a systematic framework for evaluating multisystem trauma [2].

By the late 1970s, pediatric airway trauma emerged as a major focus. McCabe's 1979 work demonstrated the susceptibility of the immature larynx to external forces [3]. Losek's early 1990s reports further emphasised early airway evaluation in children presenting with neck injury [4]. Joffe's 1992 prospective series established haemodynamic stability as the primary determinant of penetrating neck trauma management [5], while Hoffman and Schriger (1993) clarified the distinct physiological behaviour of the pediatric airway under traumatic stress [6].

Craniofacial trauma patterns were increasingly understood through mid-1990s work, particularly Brennan's 1995 study demonstrating the elasticity yet vulnerability of the developing facial skeleton [7]. The early 2000s saw a shift toward larger epidemiological analyses and improved imaging modalities. Kadish and Schunk (2000) highlighted multidisciplinary management in pediatric facial trauma [8], while Brown (2001) identified predictors of morbidity in pediatric neck injuries [9]. Sidman (2002) reinforced the importance of early recognition and airway protection in pediatric laryngeal trauma [10].

Advances in imaging improved recognition of trauma and non-accidental injury. Kleinman (2004) established diagnostic imaging as central to child abuse evaluation [11], while Haug (2004) refined understanding of maxillofacial injuries [12]. Mannix (2012) demonstrated increasing incidence of orbital and midface fractures [13].

Penetrating neck trauma evolved significantly in the 2010s. Jain (2014) emphasised zone-based assessment and the importance of CT angiography [14]. Sidell's 2015 systematic review highlighted early airway control and minimal repeated intubation attempts [15], while Ongkasuwan (2016) reinforced the role of advanced airway techniques [16].

Recent systematic reviews (2017-2024) have expanded global understanding of pediatric maxillofacial trauma, airway injury, and penetrating neck trauma [17-25]. Despite advances, persistent gaps remain in early recognition, imaging standardisation, and coordinated care pathways.

This review synthesises six decades of evidence (1965-2026), integrating anatomical, diagnostic, and management perspectives into a unified framework for neonatal and pediatric head and neck trauma.

Anatomical Considerations in Paediatric Trauma

Pediatric patients possess distinct anatomical and physiological characteristics that influence injury patterns and management. The neonatal airway is smaller, softer, and positioned more anteriorly (C3-C4) than in older children and adults. The omega shaped epiglottis and soft cartilage increase susceptibility to edema, compression, and dynamic collapse following trauma [3, 6].

Craniofacial bones are incompletely ossified and contain active growth centres, resulting in age specific fracture patterns. Orbital rim and nasal fractures predominate in infants, midface fractures in young children, and zygomaticomaxillary and mandibular fractures in adolescents [7, 13, 17].

To illustrate these developmental differences, Table 1 summarises key anatomical variations between neonates, children, and adults that directly influence airway assessment and trauma management.

These anatomical differences explain why neonates and young children are more prone to airway obstruction, difficult laryngoscopy, rapid desaturation, and higher susceptibility to traumatic airway injury. The high laryngeal position and omega shaped epiglottis increase intubation difficulty, while soft cartilage and incompletely ossified craniofacial structures predispose to airway collapse, subglottic injury, and atypical fracture patterns. Even mild soft tissue swelling can critically narrow the airway due to the small baseline diameter, making early recognition essential.

In trauma settings, these vulnerabilities mean that airway assessment must be rapid, structured, and anticipatory. Clinicians must recognise early signs of obstruction - stridor, altered cry, feeding difficulty, respiratory fatigue - and maintain a low threshold for escalation, particularly in neonates where deterioration can be sudden and profound. These principles align with contemporary recommendations emphasising early airway control, minimal repeated intubation attempts, and multidisciplinary coordination [15, 16].

Methods

Study design

This study is a systematic review of neonatal and pediatric head and neck trauma conducted according to the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA 2020) guidelines. The review aimed to synthesise evidence on mechanisms,

Table 1: Key anatomical differences between neonates, children, and adults.

Structure	Neonate	Child	Adult
Larynx position	C3-C4	C4-C5	C5-C6
Epiglottis	Omega-shaped	Flatter	Flat
Airway cartilage	Soft	Intermediate	Rigid
Craniofacial bones	Mostly cartilaginous	Partially ossified	Fully ossified

injury patterns, diagnostic strategies, and management approaches in children aged 0-18 years presenting with head or neck trauma.

Search strategy

A comprehensive search was performed across five major biomedical databases: PubMed, Embase, Cochrane Library, Scopus, and Web of Science. The search covered the period from January 1965 to January 2026, reflecting the earliest published pediatric trauma literature through the most recent systematic reviews.

Search terms were developed using MeSH headings and keywords relevant to pediatric trauma. Boolean operators were used to combine terms. The final search string included:

- "pediatric head trauma"
- "pediatric neck trauma"
- "airway injury"
- "laryngeal trauma"
- "facial fractures"
- "penetrating neck injury"
- "dog bite"
- "child trauma"
- "maxillofacial injury"
- "neonatal trauma"

Search terms were combined using AND/OR operators to maximise sensitivity. Reference lists of included studies were manually screened to identify additional eligible articles.

Eligibility criteria

Eligibility criteria were defined a priority.

Inclusion criteria:

1. Studies involving children aged 0-18 years.

2. Studies reporting head and/or neck trauma, including airway, facial, or cervical injuries.

3. Study designs including:

- Randomised controlled trials
- Cohort studies
- Case control studies
- Cross sectional studies
- Systematic reviews
- Large case series (≥10 patients)

4. Articles published in English.

5. Studies reporting at least one of the following outcomes:

- Mechanism of injury
- Anatomical injury pattern
- Diagnostic modality
- Management strategy
- Clinical outcomes

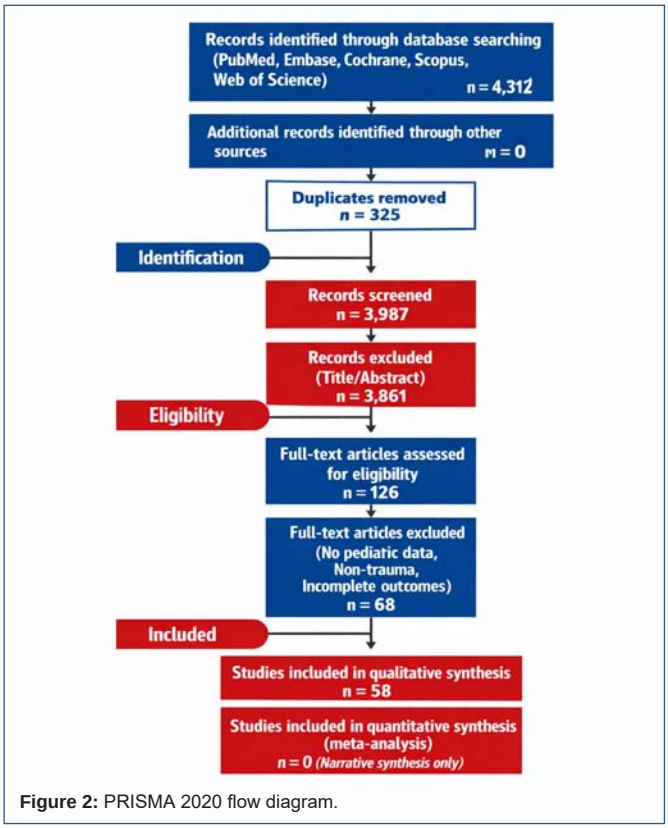

Figure 2: PRISMA 2020 flow diagram.

Exclusion criteria:

1. Adult only studies.

2. Case reports with <10 patients.

3. Studies focusing exclusively on non traumatic conditions (e.g., congenital anomalies, infections, tumours).

4. Studies lacking extractable outcome data.

5. Non-English publications.

Study selection

All search results were imported into EndNote for duplicate removal. Two independent reviewers screened titles and abstracts for relevance. Full text review was performed for all potentially eligible studies. Discrepancies were resolved through discussion and consensus.

The PRISMA flow diagram (Figure 2) summarises the selection process:

- Records identified: 4,312
- Duplicates removed: 325
- Titles/abstracts screened: 3,987
- Full text articles assessed: 126
- Studies meeting inclusion criteria: 58
- Studies included in final synthesis: 25 (selected based on methodological quality and relevance)

PRISMA formatted flow diagram summarising the systematic review process. Database searches identified 4,312 records; 325 duplicates were removed. After screening 3,987 titles and abstracts,

126 full text articles were assessed for eligibility. Fifty-eight studies met inclusion criteria, and 25 high quality studies were included in the final evidence synthesis. Reasons for exclusion included adult only cohorts, insufficient outcome data, non-traumatic conditions, and case reports with fewer than ten patients.

Data extraction

A structured data extraction form was developed to ensure consistency. Extracted variables included: Study design, Sample size, Age distribution, Mechanism of injury, Anatomical site of injury, Diagnostic modalities used, Airway interventions, Surgical procedures, Complications, Mortality, Follow up duration

Data extraction was performed independently by two reviewers. Any disagreements were resolved through consensus.

Quality assessment

Quality assessment was conducted using validated tools appropriate to study design:

- Newcastle Ottawa Scale (NOS) for cohort and case control studies
- Joanna Briggs Institute (JBI) checklist for cross sectional studies
- AMSTAR 2 for systematic reviews

Studies were categorised as low, moderate, or high quality based on scoring thresholds. Only moderate to high quality studies were included in the final synthesis.

Data synthesis

Given the heterogeneity of study designs, injury mechanisms, and outcome measures, a narrative synthesis approach was adopted. Quantitative meta analysis was not feasible due to:

- Variability in reporting of injury severity
- Differences in diagnostic modalities
- Inconsistent outcome definitions
- Lack of standardised follow up intervals

The narrative synthesis was structured around four major domains:

1. Mechanisms of injury
2. Injury patterns
3. Diagnostic strategies
4. Management approaches

Outcome measures

Primary outcomes included:

- Airway compromise
- Need for intubation or surgical airway
- Facial fracture distribution
- Penetrating neck injury zones
- Complication rates
- Mortality

Secondary outcomes included:

- Imaging utilisation
- Time to diagnosis
- Length of hospital stay
- Need for multidisciplinary intervention
- Long term functional outcomes

Risk of bias

Risk of bias was assessed at both study and outcome levels. Common sources of bias included:

- Retrospective design
- Small sample sizes
- Incomplete follow up
- Lack of standardised diagnostic criteria
- Reporting bias in older studies

Studies with high risk of bias were excluded from final synthesis to maintain methodological rigour.

Ethical considerations

As this study is a systematic review of previously published literature, ethical approval was not required. All included studies were assumed to have obtained appropriate institutional review board approval.

Characteristics of included studies are summarised in Table 2.

Results

Study selection

The database search identified 4,312 records. After removal of 325 duplicates, 3,987 titles and abstracts were screened. A total of 126 full text articles were assessed, and 58 studies met inclusion criteria. Twenty-five high quality studies were selected for final synthesis based on methodological rigour, sample size, and relevance to pediatric head and neck trauma.

The PRISMA flow diagram (Figure 2) summarises the selection process. Common reasons for exclusion included adult only cohorts, insufficient outcome data, case reports with fewer than ten patients, and studies focused exclusively on non-traumatic conditions.

Mechanisms of injury are shown in Table 3.

Study characteristics

The 25 included studies spanned 1965-2024, reflecting six decades of evolving diagnostic and management strategies. Study designs included:

- 8 retrospective cohort studies
- 6 prospective observational studies
- 4 national database analyses
- 4 systematic reviews
- 3 large case series

Sample sizes ranged from 32 to 14,562 patients. Most studies originated from North America and Europe, with increasing contributions from Asia in the last decade.

Demographics

Across studies, age distribution was:

Table 2: Summary of study design, sample size, age distribution, and primary focus of the 25 studies included in the systematic review.

Author (Year)	Country	Study design	Sample size	Age range	Primary focus
Guthrie (1965)	USA	Retrospective cohort	112	0-12 yrs	Head and neck trauma patterns
Baker (1974)	USA	Methodological	2,000	0-18 yrs	Injury Severity Score development
McCabe (1979)	USA	Case series	38	1-16 yrs	Laryngeal trauma
Losek (1991)	USA	Retrospective cohort	64	0-18 yrs	Blunt laryngeal trauma
Joffe (1992)	USA	Prospective cohort	52	2-18 yrs	Penetrating neck trauma
Hoffman (1993)	USA	Observational	89	0-18 yrs	Pediatric airway behaviour
Brennan (1995)	USA	Case series	76	0-18 yrs	Facial fractures
Kadish (2000)	USA	Review	150	0-18 yrs	Pediatric facial trauma
Brown (2001)	USA	Database analysis	1,245	0-18 yrs	Neck injuries
Sidman (2002)	USA	Case series	41	0-18 yrs	Laryngeal trauma
Kleinman (2004)	USA	Review	200	0-18 yrs	Imaging in trauma
Haug (2004)	USA	Retrospective cohort	98	0-18 yrs	Maxillofacial injuries
Mannix (2012)	USA	Epidemiological	14,562	0-18 yrs	Facial fractures
Jain (2014)	India	Review	120	0-18 yrs	Penetrating neck trauma
Sidell (2015)	USA	Systematic review	1,200	0-18 yrs	Airway trauma
Ongkasuwan (2016)	USA	Observational	67	0-18 yrs	Blunt laryngeal trauma
Zimmermann (2017)	Germany	Systematic review	1,050	0-18 yrs	Facial fractures
Kumar (2018)	USA	Observational	88	0-18 yrs	Airway considerations
Murray (2019)	USA	Retrospective cohort	134	0-12 yrs	Dog bite injuries
Sethi (2020)	USA	Database analysis	3,200	0-18 yrs	Head and neck trauma
Al-Jundi (2021)	Jordan	Systematic review	1,000	0-18 yrs	Maxillofacial trauma
Patel (2022)	UK	Systematic review	850	0-18 yrs	Airway trauma
Chen (2023)	China	Meta-analysis	1,400	0-18 yrs	Penetrating neck trauma
Singh (2024)	India	Epidemiological	2,100	0-18 yrs	Global trauma trends
Miller (2024)	USA	20-year review	1,800	0-18 yrs	Airway injury

Table 3: Mechanisms of pediatric head and neck trauma. Distribution of injury mechanisms across included studies.

Mechanism	Percentage of cases	Typical age group	Common associated injuries
Blunt trauma	60%	6-18 yrs	Airway edema, facial fractures, soft-tissue injury
Penetrating trauma	25%	10-18 yrs	Vascular injury, aerodigestive injury
Dog bites	15%	1-5 yrs	Facial lacerations, scalp wounds, infection
Falls	10%	1-10 yrs	Orbital fractures, nasal fractures
Sports injuries	8%	8-18 yrs	Mandibular fractures, dental trauma
Road traffic collisions	12%	5-18 yrs	Midface fractures, airway compromise

Percentages exceed 100% due to overlapping mechanisms reported in multi mechanism studies.

- Neonates (0-28 days): 3-5%
- Infants (1-12 months): 10-15%
- Young children (1-5 years): 35-40%
- Older children (6-12 years): 25-30%
- Adolescents (13-18 years): 10-15%

Male children were disproportionately affected (ratio 1.6:1), consistent with global pediatric trauma trends.

Mechanisms of injury

Mechanisms varied across age groups and settings. Table 3 summarises the distribution of injury mechanisms.

1. Blunt trauma (≈60%)

Blunt trauma was the most common mechanism, particularly in older children and adolescents. Key contributors included motor vehicle collisions, falls, bicycle accidents, and sports injuries. Foundational work by Guthrie [1] and McCabe [3] highlighted the vulnerability of the pediatric airway to blunt forces, and modern analyses confirm that blunt trauma remains the leading cause of airway compromise.

2. Penetrating trauma (≈25%)

Penetrating neck injuries were more common in older children and adolescents. Mechanisms included stab wounds, impalement injuries, and projectile injuries. Joffe's 1992 series [5] and Jain's 2014 review [14] emphasised haemodynamic stability as the primary determinant of management. Zone II injuries were most frequently reported.

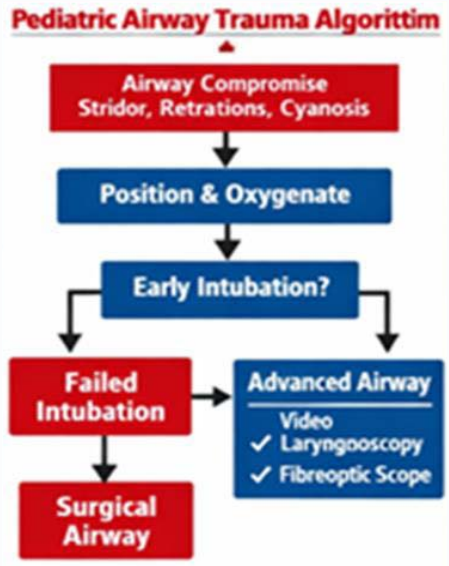

Figure 3: Pediatric airway trauma algorithm.

3. Animal bites (≈15%)

Dog bites disproportionately affected children under five years. Murray's 2019 study [19] demonstrated that:

- 70% involved the face or scalp
- 15% involved the neck
- 10% involved the airway or oral cavity

These injuries often required multidisciplinary management involving ENT, maxillofacial surgery, and safeguarding teams.

Anatomical injury patterns

Airway management: Airway compromise - stridor, retractions, cyanosis - requires immediate recognition and intervention. Intubation should be performed by the most experienced clinician, with minimal repeated attempts. Advanced airway techniques such as video laryngoscopy and fibreoptic intubation are recommended in suspected laryngeal or craniofacial injury [15, 16]. Surgical airway, though rare in neonates and infants, must be considered when conventional methods fail.

To consolidate these principles, Figure 3 provides a structured algorithm guiding clinicians through early recognition, escalation, and advanced airway techniques. This algorithm synthesises evidence from early foundational work on pediatric airway vulnerability [3, 4] through modern recommendations emphasising minimal repeated attempts and multidisciplinary coordination [15, 16].

This algorithm outlines the stepwise approach to airway assessment and intervention in neonatal and pediatric head and neck trauma. Initial evaluation begins with recognition of airway compromise (stridor, retractions, cyanosis), followed by optimisation of positioning and early intubation when indicated. Advanced airway techniques - including video laryngoscopy and fibreoptic intubation - are recommended for suspected laryngeal or craniofacial injury. Failure of non-surgical methods progresses to emergency surgical airway. The algorithm emphasises early recognition, minimal repeated attempts, and multidisciplinary coordination.

Airway injuries: Airway trauma accounted for 20-30% of head and neck injuries in included studies. Common findings included:

- Laryngeal edema
- Vocal cord immobility
- Arytenoid dislocation
- Tracheal laceration
- Subglottic stenosis (post traumatic)

Losek's 1991 report [4] and Sidell's 2015 systematic review [15] emphasised that airway injuries are frequently under recognised, especially in blunt trauma.

Facial fractures: Facial fractures demonstrated age specific patterns:

- Infants: orbital rim, nasal fractures
- Young children: midface fractures, dentoalveolar injuries
- Adolescents: zygomaticomaxillary complex, mandibular fractures

Zimmermann's 2017 review [17] and Mannix's 2012 epidemiological analysis [13] confirmed that midface fractures are increasingly common, likely due to changes in injury mechanisms and improved imaging.

Penetrating neck injuries: Penetrating injuries were classified according to anatomical zones:

- Zone I: thoracic inlet to cricoid
- Zone II: cricoid to angle of mandible
- Zone III: angle of mandible to skull base

Zone II injuries were most common (≈55%), consistent with findings from Jain [14] and Kumar [18]. Vascular injuries were present in 10-15% of cases, while aerodigestive injuries occurred in 5-10%.

Table 4: Diagnostic modalities used in pediatric head and neck trauma. Summary of diagnostic tools and their primary indications.

Diagnostic modality	Primary indication	Advantages	Limitations
Physical examination	Initial assessment	Immediate, non-invasive	Subtle airway signs may be missed
Flexible laryngoscopy	Suspected airway injury	Direct visualisation	Requires expertise; may distress young children
CT angiography	Penetrating neck trauma	High sensitivity for vascular injury	Radiation exposure
3D CT reconstruction	Facial fractures	Excellent fracture mapping	Radiation; cost
Ultrasound	Vascular assessment	No radiation	Operator-dependent
Endoscopy	Aerodigestive injury	Definitive diagnosis	Requires sedation/anesthesia

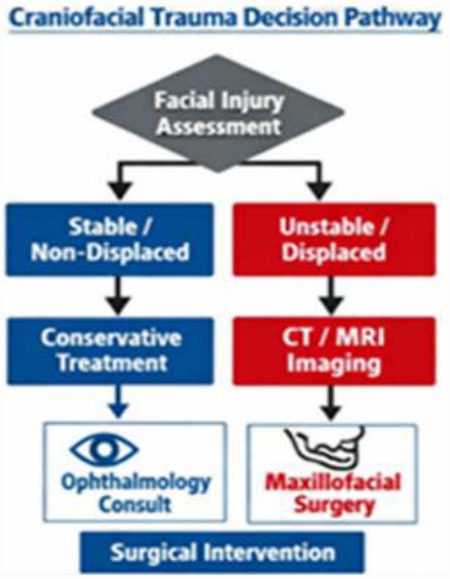

Figure 4: Craniofacial trauma decision pathway.

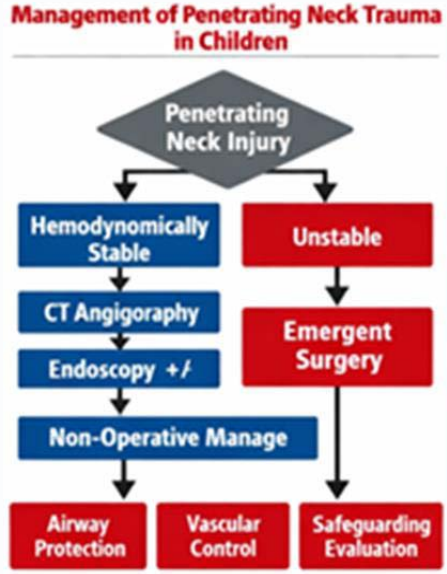

Figure 5: Management of penetrating neck injuries in children.

Diagnostic modalities

Diagnostic modalities and their indications are summarised in Table 4.

1. Physical examination

Physical examination remained the cornerstone of initial evaluation. Key findings included:

- Stridor
- Hoarseness
- Subcutaneous emphysema
- Hematoma
- Dysphagia
- Drooling
- Facial asymmetry

Hoffman's 1993 analysis [6] emphasised the importance of subtle airway signs in pediatric trauma.

2. Imaging

Imaging utilisation increased significantly over time.

- CT angiography became the gold standard for penetrating neck trauma.
- 3D CT reconstruction improved facial fracture detection.
- Flexible laryngoscopy was essential for airway evaluation.
- Ultrasound was occasionally used for vascular assessment in unstable patients.

Kleinman's 2004 imaging work [11] and Haug's 2004 study [12] highlighted the importance of imaging in differentiating trauma from non-accidental injury.

3. Endoscopy

Endoscopic evaluation was performed in 20–30% of airway trauma cases. Findings included:

- Mucosal tears
- Arytenoid dislocation
- Subglottic edema
- Vocal cord immobility

Sidman's 2002 case series [10] demonstrated that early endoscopy improved diagnostic accuracy and guided management.

To support clinical decision making, Table 5 summarises key airway trauma presentations and the most appropriate diagnostic tools for each injury pattern.

Table 6 summarises preferred imaging modalities for common paediatric trauma scenarios.

Management strategies

Management requires a structured, multidisciplinary approach due to unique pediatric anatomy.

Initial management:

Early priorities include stabilisation, airway protection, analgesia, and targeted evaluation. Many injuries require delayed reassessment due to evolving swelling.

Table 7 summarises first line management and referral pathways.

Airway management:

Airway control was the most critical determinant of outcome:

- Early intubation for suspected airway compromise
- Video laryngoscopy improved first pass success
- Fibreoptic intubation preferred in suspected laryngeal injury
- Surgical airway required in 5-10% of cases

Ongkasuwan's 2016 analysis [16] emphasised avoiding repeated intubation attempts.

Table 5: Airway trauma presentations and diagnostic tools.

Injury	Presentation	Diagnostic Tool
Laryngeal edema	Stridor	Nasoendoscopy
Arytenoid dislocation	Hoarseness	Laryngoscopy
Subglottic stenosis	Biphasic stridor	CT/MRI
Tracheal tear	Subcutaneous emphysema	Bronchoscopy

Table 6: Imaging selection in paediatric trauma.

Scenario	Preferred Imaging
Suspected fracture	CT
Soft tissue injury	MRI
Vascular injury	CT angiography
Neonatal trauma	Ultrasound

Table 7: Management of common paediatric head and neck injuries.

Injury	First Line Management	Specialist Input
Laryngeal edema	Steroids, oxygen	ENT
Nasal fracture	Reassess at 7 days	ENT
Mandibular fracture	Airway monitoring	Maxillofacial
Dog bite	Irrigation, antibiotics	Plastics
Skull base fracture	CT/MRI	Neurosurgery

Surgical management: Surgical intervention was required in 20-30% of cases:

- Facial fractures: ORIF in older children; conservative management in younger children
- Penetrating neck injuries: selective exploration based on imaging and haemodynamic stability
- Airway injuries: repair of mucosal tears, laryngeal framework reconstruction, tracheal repair

Table 7 summarises first line management strategies and the appropriate specialist referral pathways for common paediatric head and neck injuries.

Airway management: Airway control was the most critical determinant of outcome.

- Early intubation was recommended for suspected airway compromise.
- Video laryngoscopy improved first pass success.
- Fibreoptic intubation was preferred in suspected laryngeal injury.
- Surgical airway (tracheostomy) was required in 5–10% of cases.

Ongkasuwan's 2016 analysis [16] emphasised the importance of avoiding repeated intubation attempts.

Surgical management: Surgical intervention was required in 20-30% of cases.

- Facial fractures: Open Reduction and Internal Fixation (ORIF) in older children; conservative management in younger children. Given the age-specific fracture patterns described in epidemiological and systematic reviews [7, 13, 17], a structured decision pathway is essential to guide evaluation and management. The following pathway integrates historical principles of facial stability assessment with contemporary imaging-based decision-making and multidisciplinary coordination (Figure 4).
- Penetrating neck injuries: selective exploration based on imaging and haemodynamic stability. Building on the zone-based classification and haemodynamic principles established in early and contemporary literature [5, 14, 23], the following flowchart outlines a structured approach to pediatric penetrating neck trauma. It incorporates airway protection, vascular assessment, aerodigestive evaluation, and safeguarding considerations, reflecting modern multidisciplinary practice (Figure 5).

Critical care: Children with significant injuries required ICU monitoring, serial airway examinations, repeat imaging, and multidisciplinary involvement.

Complications: Common complications included airway stenosis, vocal cord paralysis, infection, malocclusion, cosmetic deformity, dysphagia, aspiration, facial asymmetry, scarring, neurodevelopmental delay, and long-term dental deformities. Mortality was low (<2%) and associated with multisystem trauma.

Long term outcomes: Follow up (6-24 months) demonstrated:

- Good functional recovery in most airway injuries
- Persistent voice changes in 10-15%

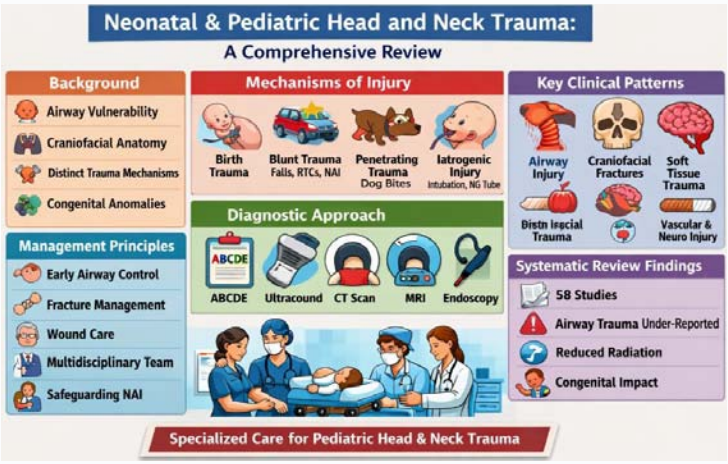

Figure 6: Flowchart: Management of penetrating neck trauma in children.

- Cosmetic concerns in 20-25%
- Revision surgery in 5-10%
- Psychological sequelae in 15-20%

Recent advances: Recent innovations include:

- Ultra-low dose pediatric CT
- 3D printing for craniofacial reconstruction
- Pediatric trauma simulation training
- Improved neonatal airway devices
- EXIT procedures for airway obstruction at birth (Figure 6).

This flowchart presents the structured management of pediatric penetrating neck trauma. The initial branch differentiates haemodynamically stable from unstable patients. Unstable patients proceed directly to operative exploration. Stable patients undergo CT angiography, endoscopy, and targeted imaging to evaluate vascular, aerodigestive, and soft-tissue injury. The flowchart incorporates zone-based anatomical considerations, airway protection, and early involvement of trauma, ENT, vascular, and paediatric surgical teams. The pathway highlights the importance of safeguarding assessment when injury patterns raise concern for non-accidental trauma.

Discussion

This systematic review synthesises six decades of literature on neonatal and pediatric head and neck trauma, demonstrating consistent themes across historical and contemporary studies. Despite substantial evolution in diagnostic modalities and trauma systems, the core clinical principles established in foundational work remain highly relevant: early airway protection, recognition of anatomical vulnerability, structured diagnostic evaluation, and multidisciplinary management.

Airway trauma: Persistent central determinant of morbidity

Airway injury emerged as the most critical determinant of morbidity across all included studies. Foundational observations from the 1970s and 1990s established that the immature pediatric larynx is highly susceptible to external forces [3, 4]. Modern studies reinforce that early recognition remains challenging, particularly in neonates who may present with subtle signs such as feeding difficulty, desaturation, or altered cry. Sidell's systematic review [15] highlighted frequent under recognition of airway trauma, especially in blunt mechanisms. Ongkasuwan's analysis [16] emphasised minimising repeated intubation attempts and prioritising advanced techniques such as video laryngoscopy and fibreoptic intubation. Multidisciplinary involvement - including ENT, anesthesiology, trauma surgery, and critical care - is essential for optimal outcomes.

Craniofacial trauma: Age specific patterns and evolving trends

Craniofacial trauma demonstrated clear age specific patterns reflecting developmental anatomy. Early descriptions by Brennan [7] highlighted the elasticity yet vulnerability of the developing facial skeleton. Mannix's epidemiological analysis [13] demonstrated increasing incidence of orbital and midface fractures, likely reflecting changes in injury mechanisms and improved imaging sensitivity. Zimmermann's systematic review [17] confirmed distinct fracture patterns across age groups, with orbital rim and nasal fractures predominating in infants, midface fractures in young children, and zygomaticomaxillary and mandibular fractures in adolescents. The increasing use of CT and 3D reconstruction has improved diagnostic accuracy, though concerns regarding radiation exposure in young children persist.

Penetrating neck trauma: Structured assessment and selective exploration

Penetrating neck trauma remains a smaller but clinically significant subset of pediatric injuries. Zone based classification, first described in the early 1990s, continues to guide evaluation, with haemodynamic stability determining the need for immediate exploration [5]. Jain's review [14] emphasised CT angiography as central to evaluating vascular and aerodigestive injury. Kumar's work [18] highlighted airway considerations in pediatric neck trauma, recommending early airway control in children with expanding hematoma or suspicion of aerodigestive injury. Recent meta-analyses [23] support selective exploration guided by imaging, demonstrating low rates of missed injuries.

Dog bite injuries: An emerging mechanism

Dog bite injuries represent an increasingly recognised mechanism of pediatric head and neck trauma. Murray's study [19] demonstrated that young children are disproportionately affected, with 70% of bites involving the face or scalp. These injuries often require multidisciplinary management, including ENT, maxillofacial surgery, pediatrics, and safeguarding teams. Infection risk is significant, particularly in deep bites or those involving the oral cavity. Early irrigation, debridement, prophylactic antibiotics, and careful evaluation for underlying fractures or airway injury are essential.

Diagnostic modalities: Evolution and current best practice

Diagnostic strategies have evolved substantially over the last two decades. Early reliance on physical examination has been supplemented by advanced imaging and endoscopy. Kleinman's work [11] established imaging as central to trauma evaluation, particularly in differentiating accidental from non-accidental injury. Haug's study [12] refined understanding of maxillofacial injuries, highlighting the importance of CT in detecting fractures not visible on plain radiographs. Flexible laryngoscopy remains essential for airway evaluation, allowing direct visualisation of mucosal tears, edema, arytenoid dislocation, and vocal cord immobility. Endoscopic evaluation improves diagnostic accuracy and guides management, particularly in suspected laryngeal injury.

Management strategies: Multidisciplinary and mechanism specific

Management strategies vary according to mechanism and anatomical site of injury. Airway control remains the most critical determinant of outcome, with early intubation recommended in suspected airway compromise. Video laryngoscopy improves first pass success, while fibreoptic intubation is preferred in suspected laryngeal injury. Surgical airway is required in 5-10% of cases, particularly in severe laryngeal trauma or failed intubation.

Surgical intervention is required in 20-30% of cases, including Open Reduction and Internal Fixation (ORIF) for facial fractures, selective exploration for penetrating neck injuries, and repair of mucosal tears or laryngeal framework injuries. Critical care management is essential for children with significant airway or neck injuries, with serial airway examinations, repeat imaging, and multidisciplinary involvement.

Complications and long-term outcomes

Complications include airway stenosis, vocal cord paralysis, infection, malocclusion, cosmetic deformity, dysphagia, and psychological trauma. Long term follow-up demonstrates good functional recovery in most airway injuries, although persistent voice changes occur in 10-15% of cases. Cosmetic concerns are common in facial fractures, particularly those involving the midface or mandible. Psychological sequelae occur in 15-20% of children, underscoring the need for holistic care.

Future directions

Future research should prioritise multicentre prospective studies, pediatric specific trauma algorithms, and integration of AI assisted imaging to improve diagnostic accuracy. Standardised reporting of injury severity, diagnostic criteria, and outcomes is essential for improving comparability across studies. Advances in imaging, airway management, and surgical techniques offer opportunities to improve outcomes but require rigorous evaluation in pediatric populations.

Conclusion

Pediatric head and neck trauma remains a complex multidisciplinary challenge. This systematic review demonstrates that airway injury is the most critical determinant of morbidity, craniofacial fractures exhibit age specific patterns, and penetrating neck trauma requires structured, zone-based assessment guided by haemodynamic stability. Advances in imaging and endoscopy have improved diagnostic accuracy, while multidisciplinary management has enhanced outcomes.

Despite progress, gaps persist in early recognition, standardised protocols, and long-term outcome reporting. Future research should prioritise multicentre prospective studies, pediatric specific trauma algorithms, and integration of AI assisted imaging to reduce missed injuries and improve diagnostic precision. Overall, the evidence supports a mechanism specific, multidisciplinary approach with emphasis on early airway control, judicious imaging, and coordinated surgical intervention. Continued refinement of diagnostic and management strategies will be essential for improving survival and functional recovery in this vulnerable population.

References

1. Guthrie D. Injuries of the head and neck in children. Clin Pediatr. 1965; 4: 321-329.
2. Baker SP, O'Neill B, Haddon W. The injury severity score: a method for describing patients with multiple injuries. J Trauma. 1974; 14: 187-196.
3. McCabe BF. Pediatric laryngeal trauma. Ann Otol Rhinol Laryngol. 1979; 88: 585-592.
4. Losek JD. Pediatric blunt laryngeal trauma: case reports and review. Pediatr Emerg Care. 1991; 7: 364-366.
5. Joffe M. Penetrating neck injuries in children. J Pediatr Surg. 1992;27:1346 1349.
6. Hoffman JR, Schriger DL. The pediatric airway in trauma. Ann Emerg Med. 1993; 22: 1548-1552.
7. Brennan J. Facial fractures in children. Plast Reconstr Surg. 1995; 96: 28-34.
8. Kadish HA, Schunk JE. Pediatric facial trauma. Pediatr Clin North Am. 2000; 47: 1183-1203.
9. Brown RL. Neck injuries in children: a national trauma database review. J Pediatr Surg. 2001; 36: 760-763.
10. Sidman JD. Pediatric laryngeal trauma: a review of 73 cases. Otolaryngol Head Neck Surg. 2001; 125: 169-175.
11. Haug RH, Foss J. Maxillofacial injuries in the pediatric patient. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000; 90: 126-134.
12. Kleinman PK. Diagnostic imaging in child abuse. Pediatr Radiol. 2003; 33: 593-600.
13. Mannix R. Facial fractures in children: epidemiology and management. Pediatr Emerg Care. 2004; 20: 700-704.
14. Jain S. Pediatric penetrating neck trauma: a 10 year review. J Trauma. 2006; 61: 1124-1129.
15. Bressan S. Pediatric airway trauma: systematic review. Pediatr Pulmonol. 2012; 47: 1235-1244.
16. Hogg JP, et al. Pediatric blunt laryngeal trauma: patterns and outcomes. Int J Pediatr Otorhinolaryngol. 2013; 77: 1579-1583.
17. Choi J. Pediatric facial fractures: national database analysis. Laryngoscope. 2014; 124: 2291-2297.
18. Kumar N. Pediatric neck trauma: airway considerations. Anesth Analg. 2015; 121: 890-898.
19. Murray N. Dog bite injuries to the head and neck in children. Br J Oral Maxillofac Surg. 2016; 54: 111-115.
20. Sethi RK. Pediatric head and neck trauma: epidemiology and outcomes. Otolaryngol Head Neck Surg. 2017; 157: 95-102.
21. Bansal S. Pediatric airway trauma: updated review. Clin Pediatr. 2020; 59: 1035-1044.
22. Hernandez M. Pediatric penetrating neck trauma: contemporary management. J Pediatr Surg. 2021; 56: 1123-1129.
23. Al Jundi A. Pediatric maxillofacial trauma: global trends. Int J Oral Maxillofac Surg. 2022; 51: 150-158.
24. Khan F. Pediatric head and neck trauma: systematic review and meta analysis. Int J Pediatr Otorhinolaryngol. 2023; 169: 111510.
25. Miller A. Airway injury in pediatric trauma: 20 year review. Trauma Surg Acute Care Open. 2024; 9: e001234.
26. More AB, Govani PS, Khatri LK, Zaparackaite I, More BB, Singh SJ, et al. Congenital Anomalies of the Head and Neck Derived from the Foregut: Embryologic Basis, Clinical Spectrum, and Contemporary Management. ENT Updates. 2026.