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Traumatic injuries in maxillofacial region in children: emergency procedures to be adopted

Lesiones traumáticas en la región maxilofacial de niños: procedimientos de emergencia para adoptarse

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ABSTRACT: Pediatric facial trauma differs from adult facial trauma because it necessitates a basic knowledge of the developing patient. Traumatic injury is still the leading cause of death in children, with much of it being the result of a brain injury. The craniofacial region of children grows rapidly, making it more visible and vulnerable to harm. The frequency and causation of facial fractures in children change with age. Understanding the patient's dentition stage can have a major impact on treatment management. The development of the alveolus is tooth dependent, and the lack of growing teeth will have a substantial influence on the growth and development of the maxilla and mandible, and hence on treatment. This review lays emphasis on maxilofacial trauma in the children.

KEY WORDS: ATLS, pediatric maxillofacial trauma, pediatric distraction osteogenesis, tracheostomy, airway management dilemmas.

INTRODUCTION

Facial injuries are prevalent in children however the majority of these injuries were hardly serious or life-threatening. Due to the lack of sinus development and pronounced buccal fat pads, pediatric patients have unique facial anatomy with increased facial bone strength and elasticity, decreasing the risk of facial trauma; however, their large head size and poorly developed neck strength increase the risk of head and neck injury. If a patient has significant maxillofacial trauma, there is a 10% chance of an associated cervical spine injury (Kushner & Jones, 2021).

As children develop, the patterns of fracture and mechanisms of injury also changes. The incidence of facial fractures is less, but increases with age. One study indicated that children of ages 0–5 comprised 20.2 % of facial fractures, in 6–11 age group 32.8 %, and the largest group was 12–18 year-olds which accounted for almost half of the pediatric facial fractures (47 %). The cause of injuries for 0–5 age were daily activities of living, while for 6–11-year-old group were motor vehicle collisions, play, and bicycle accidents. Whereas for 12–18-year-old group, violence and sports were the leading cause of injuries (Kushner & Jones, 2021).

According to the Centre for Disease Control in the United States head and neck injuries accounted for 17 % of hospitalized injuries, 20 % of initial visits to EDs, and 15 % of injuries reported. Furthermore, children account for nearly 14 % of all facial fractures (Kushner & Jones, 2021).

Autologous blood transfusion. The "collection and reinfusion of the patient's own red blood cells" has been known to mankind since the time of Philip Physic of Philadelphia, who transfused the blood taken from a post-partum hemorrhage patient in 1785 (Ravindra *et al*., 2015). The different types of autologous blood transfusion are mentioned in Table I.

Table I. Types of autologous blood transfusion.

Predeposit autologous donation (PAD)	Intraoperative cell salvage (ICS)	Postoperative cell salvage (PCS)	Acute normovolaemic haemodilution (ANH)
- It is the banking of a patient's red blood cells prior to surgery. - Most healthy adult individuals can donate up to three red cell units before elective surgery because red cells have a 35-day storage life at 4°C. - Iron supplements, often combined with erythropoietin, may be administered to patients to avoid anaemia and enable for more donations to be received. -	-collection and reinfusion of blood spilt during surgery -commercially accessible, mostly automated equipment are now routinely employed in hospitals for elective and emergency surgery with significant blood loss. -Blood is filtered to remove particulates before aspiration into a collection reservoir, where it is anticoagulated with heparin or citrate. -The saved blood can be centrifuged and cleansed in a closed, automated system if enough blood is recovered and the patient loses enough blood to necessitate transfusion. -The patient must be transfused with red cells suspended in sterile saline solution within 4 hours of processing. In the operating room, the reinfusion bag should be labelled with the patient identifiers generated from the patient's ID band. Except in cases where a leucodepletion filter is required, the red cells are transfused through a 200 m screen filter. Patients who are undergoing elective operations that may involve the use of ICS should offer informed permission after receiving all pertinent information.	-PCS is mostly utilised in orthopaedic treatments, such as knee or hip replacement and scoliosis correction. -Blood is drawn from wound drains and filtered or cleansed in an automated system before being reintroduced to the patient. -Simple filtering systems for unwashed red cell reinfusion are often utilised when blood losses are predicted to be between 500 and 1000 mL -Salvaged blood must be collected in the timeframe recommended by the manufacturer (typically 6 hours), and the reinfusion must be monitored and documented in the same way as donor transfusions are. -PCS is relatively inexpensive, has the ability to limit donor blood exposure, and is accepted by the majority of Jehovah's Witnesses.	-Several units of blood are collected into normal blood donation packs just before surgery in ANH, and the patient's blood volume is maintained by infusion of crystalloid or colloid fluids at the same time. -The blood is kept at room temperature in the operating room and reinfused at the conclusion of the procedure or if there is substantial bleeding. -risks includes Fluid overload, heart ischemia, and incorrect blood into patient. -ANH appears to be most successful as a blood conservation measure in surgery with large blood loss, which is currently uncommon in elective heart surgery, according to mathematical modelling.

Advanced Trauma Life Support (ATLS) and facial trauma

Initial resuscitation (ABCs – Airway, Breathing, Circulation). The American College of Surgeons established Advanced Trauma Life Support (ATLS) guidelines for the initial trauma resuscitation of the pediatric patient. The airway, breathing, and circulation (ABC) are the first priorities. The ABCs are performed in the same manner as any other resuscitation. A Glasgow Coma Scale (GCS) score < 8, inability to maintain a clear airway owing to oropharyngeal damage, and shock are all indications for intubation (Wulkan & Clifton, 2017).

Effective bag-mask ventilation is a valuable skill that can help stabilize a patient's health until someone skilled of intubating a kid arrives. In children, the necessity for a surgical airway is quite rare. In both adolescents and adults, an emergency cricothyrotomy is the preferred surgery. A surgical airway is frequently constructed with a tracheotomy in younger children. Ventilation should be done using an inline pressure monitor and at a pace that is appropriate for the patient's age. It's easy for practitioners who aren't used to working with children to overlook that new-borns require numerous little breaths (Wulkan & Clifton, 2017).

After securing the airway and ensuring appropriate gas exchange, the focus should go to establishing adequate circulation. It is necessary to set up two intravenous lines. An interosseous line can be put in an emergency circumstance. For trauma resuscitation, large-bore peripheral intravenous lines are adequate. Central access should only be used in cases where peripheral access is inaccessible (Wulkan & Clifton, 2017).

Secondary survey (D and E). After the ABCs, Disability and Exposure are the next priorities. That is, a thorough neurological examination, including GCS, is carried out. Fractures and neurological impairments in the extremities should be evaluated. To assess tone and search for gross blood, a rectal exam is conducted. The patient's clothes are taken off and they are log-rolled to check for abrasions, seat belt signs, and penetrating injuries, as well as to palpate the spine for step-offs or crepitance (Wulkan & Clifton, 2017).

Procedures to be adopted in a patient with maxillofacial trauma following examination with ATLS protocol are shown in Fig. 1.

Airway Management Dilemmas

The first step in the management of trauma patients is assessment of the airway according to the ATLS protocols. The following are the criteria for intubating a maxillofacial trauma patient: Ineffective Bag-mask ventilation, and extended airway control is required. respiratory collapse, loss of protective laryngeal reflexes, and Glasgow coma score (GCS) ≤ 8, uncontrolled bleeding into the oropharynx, and anticipated massive swelling of the laryngeal tissues. A child's airway is smaller, the oropharyngeal soft tissues are often larger, and the larynx is positioned more cephalad when compared to adult patients. These anatomical traits affect both airway resistance and the difficulty of intubation. If intubation cannot be accomplished, a surgical airway may be required. Vivino *et al* in their study noticed that Intubation was significantly related to fractures of the midface, frontal sinuses, spine, skull, and pelvis, as well as depressed GCS scores and traumatic brain injury (Viviano *et al*., 2017).

Current guidelines for intubation in trauma do include maxillofacial injuries, but are a little vague and can be misleading; bilateral fractures of the mandible are a common injury, frequently cited as an indication for intubation, but rarely need it – Only when combined with a lowered Glasgow Coma Scale (GCS) or spinal immobilization do it represent a substantial concern. Other indications specific to facial trauma include anticipated gross swelling, to aid in hemorrhage control, or in 'significant' facial injuries requiring a long inter-hospital transfer; however, the definition of 'significant' requires clinical judgement on a case-by-case basis and is often based on the mechanism of injury (Perry, 2016).

Distraction osteogenesis of head and neck

Distraction osteogenesis (DO) is a procedure of progressively lengthening bone following osteotomy. After a brief period of delay, distraction begins at a gradual and steady pace. The bone segments are separated by modest increments, and between the two segments, new bone formation is induced (Tibesar & Sidman, 2008; Tibesar *et al*., 2010).

Codvilla was the first to use this technique in orthopaedic surgery about a century ago. Ilizarov improved the method and defined the principles of its application in extending the long bones of the extremities throughout the 1940s. Snyder *et al*. (1973) utilizing a canine model, published the first experimental study with DO in the craniofacial area

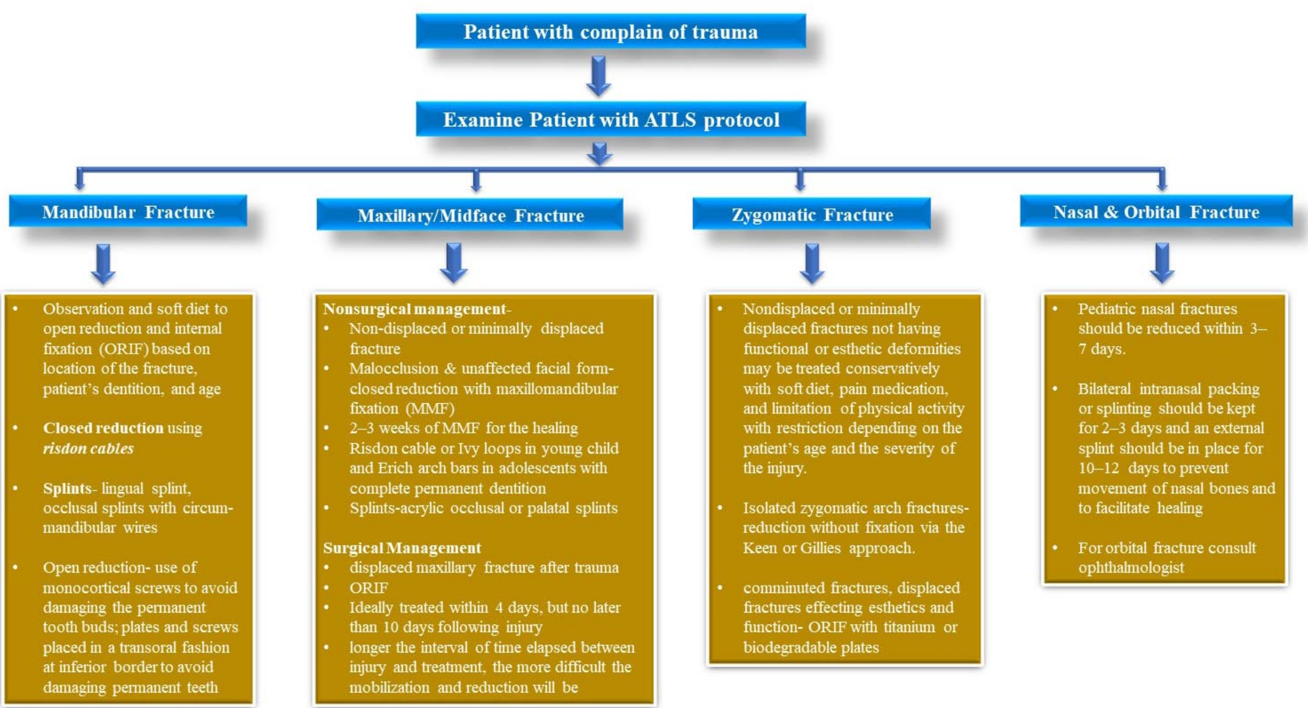

Fig. 1. Procedures to be adopted in a pediatric patient with the complain of trauma in maxillofacial region.

in 1973. McCarthy *et al*. (1992) published the first clinical case of craniofacial DO in 1992. In individuals with congenital hypoplasia, they documented progressive mandibular elongation. In 1999, Judge *et al*. (1999) published a case of employing mandibular distraction osteogenesis (MDO) to alleviate upper airway blockage in a new-born, while Sidman *et al*. (2001) published a study in 2001 demonstrating the treatment of upper airway obstruction in 11 children with MDO. This was the first time a novel method to tongue base airway blockage caused by micrognathia was used, and the early results were encouraging (Tibesar *et al*., 2010).

Indications for mandibular distraction osteogenesis

The elongation of the mandible has been one of the most effective uses of pediatric distraction osteogenesis in the craniofacial skeleton. Several studies have been reported that show that mandibular distraction osteogenesis (MDO) is a safe and effective treatment for individuals with severe respiratory obstruction caused by micrognathia or retrognathia (Tibesar & Sidman, 2008; Hong & Bezuhly, 2013).

Complications of mandibular distraction osteogenesis

Multiple phases and procedures are involved in the MDO process. Each phase poses distinct difficulties for the surgeon and exposes the patient to the risk of complications. Wound infection, pin loosening with initial loss of distraction forces, incorrect vector control resulting to a malpositioned bone segment, bony non-union, premature bony consolidation, inferior alveolar nerve hypesthesia, and facial nerve weakening are all recent MDO complications. Kleine-Hakala *et al*. (2007) discovered that 13 of the 17 children studied had problems with their developing molars. Temporomandibular joint abnormalities, ankylosis, and disruption of following mandibular growth with malocclusion are further long-term issues (Tibesar & Sidman, 2008; Hong & Bezuhly, 2013).

Tracheostomy

Surgical access to the trachea has been utilized since ancient times, but Armand Trousseau pioneered the contemporary age of tracheostomy in the mid-1800s to treat infants with diphtheria-associated dyspnoea. Chevalier Jackson established the procedure as we know it now in the early twentieth century. Tracheostomy is a life-saving treatment, however earlier research suggests that youngsters are at higher risk than adults. Due to improved survival of preterm new-borns and those with severe congenital defects, the criteria for tracheostomy in pediatric patients have changed dramatically over the previous several decades. Earlier, upper airway obstruction due to infectious diseases was the most common cause for tracheostomy, but now, the majority of pediatric tracheostomies are performed for prolonged ventilation, laryngotracheal stenosis, trauma, neurological disorders, and airway obstruction due to craniofacial abnormalities (Singh & Zubair, 2021).

During surgical repair of a type IV laryngotracheoesophageal cleft, a tracheostomy is not recommended since it can erode the posterior suture line and cause the repair to collapse. Although many children eventually require tracheostomy when the repair is solidly healed due to tracheomalacia, which precludes extubation, it is better to manage the airway with a nasotracheal or orotracheal tube during the postoperative period with the kid remained paralyzed (Neeraj, 2023).

It is difficult in pediatric patients, because a child's neck is anatomically different from an adult's neck in the following ways:

- As the pleura's dome reaches into the neck, it is likely to get damaged.
- The trachea is malleable and can be difficult to palpate.
- The trachea can be readily retracted to a large amount with little pull, and care must be taken to separate it from the carotid vessels.
- The neck is short, and there is less working space.
- The cricoid can be injured if it is not correctly identified.

Cardio pulmonary resuscitation (CPR)

CPR is a fundamental life support procedure used to administer oxygen to the heart, lungs, and brain until proper medical care arrives to restore normal cardiopulmonary function. Its order was shifted from A-B-C (Airway – Breathing – Circulation) to C-A-B (Compression- Airway- Breathing). Before reassessing heart rhythm, chest compressions must be sustained for 2 minutes (2 minutes = equivalent to 5 cycles 30:2) (Wyckoff *et al*., 2021).

Golden rules:

• Ensure high quality chest compressions: rate, depth, recoil.

• Plan actions before interrupting CPR.

• Minimize interruption of chest compressions.

• Early defibrillation of shockable rhythm.

Paediatric Basic and Advanced Life Support (Van de Voorde *et al*., 2021). Steps taken while performing pediatric basic life support (Fig. 2) and advanced life support (Fig. 3) are mentioned below.

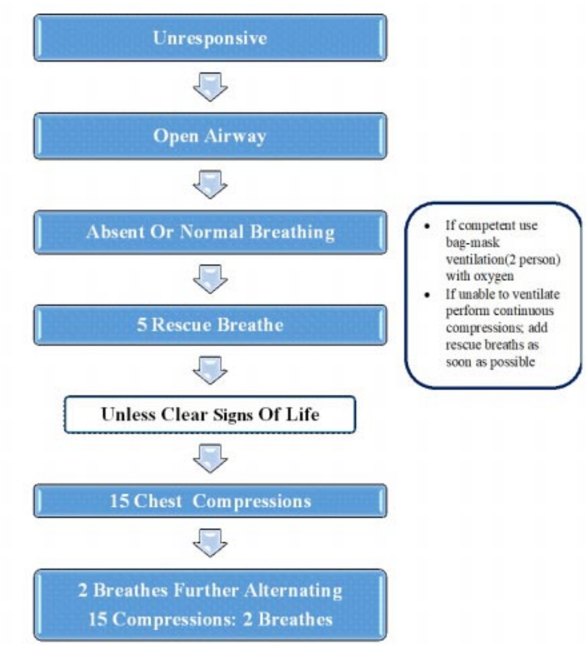

Fig. 2. Flowchart enlisting steps for pediatric basic life support. Adapted from Van de Voorde *et al*., 2021.

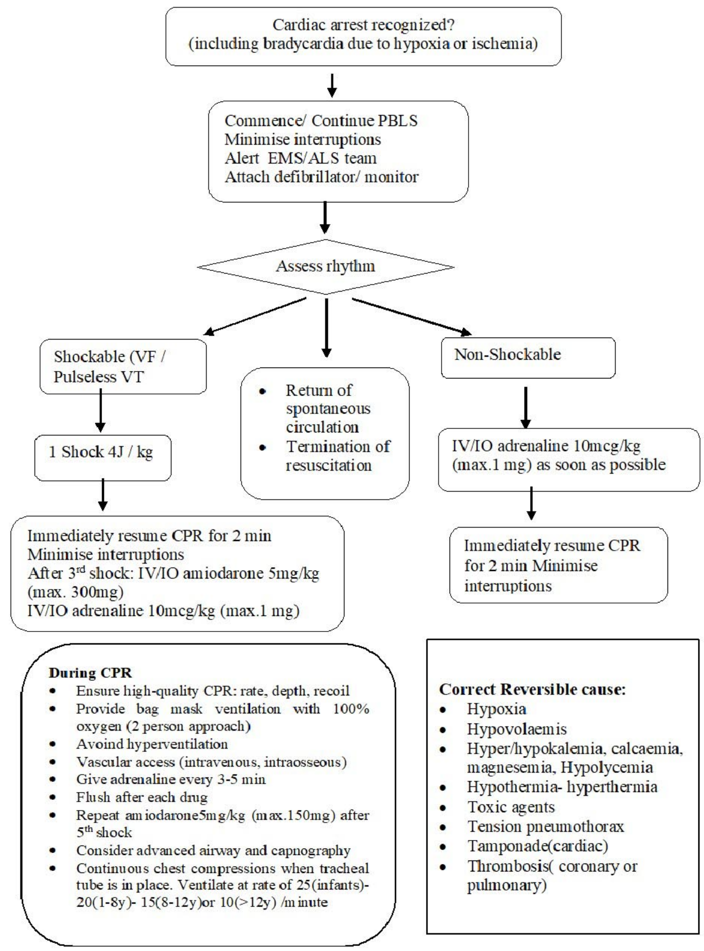

Fig. 3. Description of pediatric advance life support. Adapted from Van de Voorde *et al*., 2021.

Bleeding Haemostasis

The hemostatic systems of children and adults are dissimilar. Maureen Andrews coined the phrase "developmental haemostasis" in the 1980s to characterise the changes in the coagulation system as it evolves through time, from early intrauterine foetal development to postnatal and paediatric life, maturity, and finally geriatric systems. At birth, platelet count rises briefly before falling to adult levels after a year. Despite the fact that platelet functions are suppressed during the neonatal period, new-borns' bleeding time and platelet closure time (PFA-100) were shown to be reduced until the end of the first month of life. Von Willebrand factor was reported to be elevated in new-borns and to decrease reaching adult levels after 1 year of age (Mousa, 2021).

CONCLUSION

In general, isolated facial fractures in children are infrequent, although they are more likely following major trauma. These fractures are more common in boys, and their frequency increases with age. Motor vehicle accidents, falls, and sports-related injuries are the most common causes of pediatric facial fractures. Although nasal fractures are the most common type of facial fracture in children of all ages, mandibular fractures are the most common type of pediatric facial fracture observed in hospitals. Condyle fractures and dentoalveolar injuries were treated with closed reduction. In youngsters, open reduction and plate fixation are the management choices. After the fracture heals, the titanium plates are removed. Fractures of the pediatric facial skeleton have unique characteristics, necessitating specialized understanding for diagnosis, treatment, and follow-up.

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Author contributions: The research was carried out with the equal participation of all authors, who contributed equally to the collection and analysis of data, as well as to the writing of the article. All authors have read and accepted the published version of the manuscript.

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RESUMEN: Los traumas faciales en pediatría difieren de los adultos debido a las condiciones básicas del crecimiento del paciente. Lesiones traumáticas son aún consideradas causas de muerte en niños, resultando en muchos casos con daño cerebral primario. La región craniofacial de niños crece rápidamente, permitiendo una mayor visibilidad y vulnerabilidad a daños. La frecuencia y causas de las fracturas faciales en niños cambia con la edad. Se debe entender que el estado de dentición pueden tener un alto impacto en el manejo terapéutico. El desarrollo del alveolo es relacionado con los dientes maxilares y mandibulares y con el tipo de tratamiento. Esta revisión instala el énfasis en trauma maxilofacial en niños.

PALABRAS CLAVE: ATLS, Trauma maxilofacial pediátrico, distracción osteogénica pediátrica, traqueotomía, dilema en el manejo de las vías respiratorias.

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