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THE ROLE OF SPORT-RELATED NASAL BONE FRACTURE IN DEVELOPMENT OF SLEEP APNOEA IN CHILDREN

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ABSTRACT

Sport-related injuries have been reported as one of the top three causes of nasal bone fractures in the paediatric population regardless of the region. The most common sport disciplines responsible for nasal bone fractures are ball games like football, basketball and baseball. The diagnosis of nasal bone fracture is especially difficult in children consequential to a different anatomical structure of their nose than that of an adult's. Masked by edema etc it is frequent for a paediatric fracture to be omitted on first examination, therefore it is crucial for physicians to take history and examine the young patients very carefully despite the child's potential non-cooperative spirit. Paediatric nasal fractures are most commonly managed with closed reduction as surgical treatment is often delayed until the nose's development is complete, which occurs around adolescence, in order to avoid interfering with the growth centre. This approach may result in various post-traumatic complications, typically requiring frequent follow-up visits and secondary surgical treatment. As a result, it is critical to pay close attention to the underlying structural nasal structure during the initial diagnosis and treatment to avoid complications such as septal hematoma, septal deviation, and nasal obstruction. This review aims to outline the most frequent and severe long-term complications, stress the significance of early diagnosis and treatment, and provide strategies for preventing nasal bone fractures both re-injury and re-injury in children. Additionally, we would like to explore the likelihood that children will experience post-traumatic nasal obstruction, which can subsequently result in sleep apnea, reduced quality of life, and impaired athletic performance.

KEYWORDS

Paediatric Nasal Bone Fracture, Sport, Athletes, Nasal Trauma, Complications, Septal Deformation, Sleep Apnea

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1. Introduction:

Nasal bones, the thinnest and most anterior facial bones, are especially vulnerable to injury. They are the third most frequently fractured bone in the adult human body and the most often fractured bone in the face. In the paediatric population, nasal bone is less damaged due to their anatomical features differing from those of adults, children's nasal bone is softer and more elastic due to their higher cartilage to bone ratio, additionally, it has a lower frontal projection. Even so, 30% of all paediatric maxillofacial fractures occur in the nasal bone, making it the most often injured region. (Xiao et al. 2022; Cakabay and Ustun Bezgin 2018) According to reports, nasal fractures rank among the top three facial bone fractures that occur in children. (Derosiers 2011) Facial trauma accounts for around 10% of all sports-related injuries, and nasal fractures account for more than 60% of those injuries. (Xiao et al. 2022) Nonetheless, most children will inevitably suffer an injury to the nose at some point of time, especially boys, who are three times more likely to sustain a nasal bone fracture in all age groups. (East and O'Donaghue 1987; Hwang 2023) Patients with nasal bone fractures experience effects even after the injury heals. The damage to the nose may have a lasting impact on appearance over time and persist even after it has been treated suitably. (Xiao et al. 2022) Rearrangement of the internal nasal structure after trauma might impact breathing, smelling, and sleeping. Furthermore, revision operations, surgical reduction, and emergency consultations can cause patients to experience substantial emotional and financial strain. (Xiao et al. 2022) Significant functional and cosmetic impairment may result from disruption of the growth centres necessary for healthy development. (East and O'Donaghue 1987) The nasal structure is critical to athletic performance since it is responsible for an effective oxygene exchange, air humidification and immunologic protection particularly during the periods of high energy demand. Thus, an athlete experiencing any nasal issue is more likely to suffer from poor performance and general health. (Escalona and Okamura 2024) These reasons call for a thorough examination of the patient who sustained any nasal trauma and a prompt referral, when necessary, for a specialist's opinion. Although it might not be needed for many years, reconstructive surgery is frequently required. (East and O'Donaghue 1987) This review will provide an understanding of the current literature surrounding nasal bone fractures among children active in sports, their management and potential short-term and long-term complications.

2. Methods and materials:

The search phrases "nasal fracture or nasal trauma" AND "sport or athletes" AND "paediatric or children" were used in a PubMed search. The searches yielded 489 results, 385 of which were duplicates and thus removed, while 104 titles received a first title and abstract evaluation. This technique generated 63 articles for full text analysis, which was carried out by two writers. Studies that did not discuss a sport-related cause or incidence of nasal bone fracture in children were removed, as were papers published entirely in English. Following the investigation, only 19 papers fit the criteria for this study.

3. Anatomy:

In adults, the nose consists of skeletal and cartilaginous parts as well as a fibrous connective tissue binding them together. The skeletal structure is composed of two nasal bones, the nasal part of the frontal bone and the frontal processes of the maxilla. The cartilaginous structure is made up of the cartilage of the septum, the lateral nasal cartilage, the greater and the lesser alar cartilages. (Bochenek and Reicher 2011)

In paediatric population, nasal bone fractures are less frequent due to the fact that the nasal framework is more cartilaginous than bony and has less frontal projection than in adults. In younger children, the nasal bones are separated in the midline by an open suture line, and laterally the nasal bones overlap the frontal processes of the maxilla (Cakabay and Ustun Bezgin 2018; Wright et al. 2011) During early childhood, the external nose remains soft and squared. Prior to puberty, the adolescent nose begins to narrow and lengthen. By the time they are 12 years old, females reach the majority of adult nasal development, while males reach it at 15 years old. Most nasal growth happens in two separate growth spurts, between the age of two to five, and then again during puberty. Growth typically ends by the ages of 16 to 18 for girls and 18 to 20 for boys, while the nasal septum might continue to grow until the age of 25. Due to their knowledge of growth phases, many surgeons choose to postpone rhinoplasty procedures until after the teenage nasal growth phase. (Zalzal et al. 2018; Wright et al. 2011)

4. Results:

In a 10-year research conducted in a private practice clinic in a central Mississippi area with a population of around 350,000, 91 nasal injuries were investigated, 59 of which (64.8%) were fractures. The majority of nose injuries occurred in team sports such as basketball, baseball, football, soccer, and softball. (Cannon et al. 2011)

As reported by a statewide survey conducted in the United States from 2008 to 2013, nasal fractures were the most common type of facial fractures, accounting for 67.2% of them, in combat sports (sports evaluated included boxing, wrestling, and martial arts). Particularly, wrestlers present at a far younger age than their boxing and martial artist peers. (Hjjot 2016)

According to a 2009–2013 study, the majority of baseball-related face injuries in the USA occurred in individuals under the age of 18. Nasal bone fractures accounted for 60.6% of all facial fractures. (Cranial 2015)

A study conducted in the United States between 2010 and 2014 on face injuries experienced while playing football revealed that the nose was the most prevalent site of fractures (75,1%). Football players under the age of 18 had a lower risk of fracture than adults. According to the data, the number of soccer-related face injuries reported to emergency departments remained generally consistent and even reduced between 2013 and 2014. (Bobian et al. 2016)

According to a systematic review by Xiao et al in 2022, the number of nasal fractures decreased by 47% between 2009 and 2018. Reduced participation in sports may be one factor contributing to the drop in recreational nasal bone damage. Ball sports were the major cause of sport-related nose bone fractures in all ages and genders, with baseball being the most common among youngsters. Bicycles were the most common non-ball-related cause, accounting for only 5% of all nose bone fractures. Popularity may account for the sports with the highest prevalence of nose bone fractures. According to data, basketball is the most popular ball sport among adults in the United States, and it is also the most common sporting cause of nose bone fractures. Football is more popular than baseball or softball, yet it causes less nasal bone fractures, which could be explained by the fact that basketball, baseball, and softball use hard balls aimed at the upper body and soccer uses softer balls closer to the lower body. Baseball is the most common cause in young patients, most likely owing to the popularity of baseball leagues. Trampolines, cheerleading, and playground equipment are other potential causes of fractures in paediatric patients, however they account for a smaller number of fractures. Overall, persons under the age of 18 account for a slight majority of nasal fractures (55.5%). (Xiao et al. 2022)

From 2010 to 2014, in the United States, 63.1% of all ED visits for paediatric bicycle-related facial trauma were caused by lacerations, 27% by abrasions or contusions, and 7% by fractures. Nasal fractures

accounted for 36% of all facial fractures. Notably, the prevalence of face fractures increased considerably with age. Fractures accounted for only 2% of face injuries in children under 5 years old, versus 13% in teenagers. (Svinder 2015)

Svider et al in 2016 evaluated ED visits from 2010 to 2014 for children injured from winter activities like snowboarding, skiing, ice skating and sledding/tubing. Fractures accounted for only 5.5% of the 841 entries. More than 60% of these involved nasal fractures. Although winter sports account for 5% of facial injuries, the proportion of facial fractures sustained rose dramatically with age, with teens having a significantly greater prevalence (10.2%) than those in younger age categories (3.9%-4.7%). (Svider et al. 2016)

789 entries from around the United States were analysed for swimming and diving-related injuries in children over a 10-year period from 2007 to 2016. The annual incidence fluctuated but progressively increased from 2013 to 2016. Laceration was the most commonly diagnosed condition (65%), followed by abrasion/contusion (22%), and fracture (9%). The nasal bones were the most common site of facial fractures (87%). Overall, there were more swimming injuries (74%), but more diving injuries 12% vs. 7% swimming injuries that ended in a fracture. In addition, teenagers were more likely than children aged 1 to 6 (0.8%) or 7 to 12 (4%) to get fractures (22% of injuries) while participating in the same exercises. (Guys et al. 2018)

Between 2000 and 2005, 167 children aged 0 to 18 were examined in the emergency room at Children's Hospital of Pittsburgh of the University of Pittsburgh Medical Centre, with injuries caused by sports. The ages of 13 to 15 years old saw the highest frequency of fractures connected to sports (40.7 percent). It is during this time that youngsters start playing more contact sports and are less closely watched by adults. The most prevalent fractures (35.9%) were nasal, which is consistent with the midface's growth and increased prominence at this age. (MacIsaac et al. 2013)

Ten years of data on fractures sustained while playing golf, from 2009 to 2018, were examined. On average, there were eleven fractures per year. Patients under the age of 18 accounted for 55.3% of all facial fracture cases, with nasal fractures accounting for the most prevalent fractures (25.4%). In contrast, underage golfers made up just 10.3% of all golfers. (Oska et al. 2020)

Between 2001 and 2020, the American database documented 1455 gymnastics-related head and neck traumatic injuries. Unlike other sport-related injuries, the majority were found in females (65.8%). The paediatric age group (≤18 years) accounted for 92.7% of all presenting cases. Fractures (21.2%) were the third most prevalent type of injury, followed by lacerations and dental injuries. The nose accounted for 45.8% of all head and neck fractures. (Abdou et al. 2024)

In Korea, the predominant causes in 12 to 14 year olds were violence (38.33%) and sports (28.89%), similar findings were observed in the 15 to 17 year olds (32.92% due to violence and 34.16% due to sports); overall, sports were the third most common cause of facial injuries. Nasal bone fractures accounted for 69% of all fractures; the incidence declined with age. (Yu et al. 2019)

The study examined patients who were admitted to Southeast Ireland's Waterford Regional Hospital between August 2009 and December 2010. Most of the patients were younger than twenty years old, four months old being the youngest child evaluated for a nasal injury. Football led the list of sports-related nasal injuries (45.6%), followed by rugby (21.9%) and hurling (10.5%). Even with the advent of protective gear, one in ten sports-related nose injuries are still caused by hurling. (Basheeth et al. 2015)

One hundred instances of traumatic nasal fractures presenting to the paediatric otolaryngology service at an urban, tertiary paediatric level-1 trauma centre were assessed throughout the course of a three-year study period, which ran from October 2010 to September 2013. 13 years old was the average age at presentation (4 weeks–18 years old). Overall, the most common mechanism of injury was sports-related trauma (28%) which accounted for 33% of all nasal injuries in the 12–18 years group and 24% in the 6–11 age group. There were no reports of sport-related nasal bone fractures in children under the age of five. (Liu et al. 2015)

A study involving radiologically verified facial fractures was conducted at Children's Memorial Hermann Hospital between January 2006 and December 2015. Out of the 1274 patients, 135 patients (10.59%) had facial fractures as a result of sports-related injuries. Bicycling and baseball/softball participation were linked to fractures more commonly. Nasal fractures were the third most frequently found fractures following the most common - orbital and mandibular fractures. (Cepeda et al. 2021)

Hwang et al's systematic review from 2017 showed that ball-sports accounted for the majority (84.2%) of nasal bone fractures. This percentage was noticeably higher than the comparable figures for non-team sports (9.4%) and fight-related sports (6.4%). The most common cause of nasal bone fractures was football (23.6%), which was followed by rugby (12.1%), baseball (12.7%), and basketball (16.6%). It is worth noting that the

rate of nasal bone fractures (6.4%) was lower in combat sports. This is thought to be due to athletes' ability to protect their faces during games and the use of face protectors. (Hwang et al. 2017)

Between February 1996 and April 2007, 236 patients with facial bone fractures from different sports received care at the Inha University Hospital's Plastic and Reconstructive Surgery Department in Incheon, South Korea. The 11 to 20 year olds had the highest frequency of sports-related facial bone fractures (40.3%). Soccer was the most common cause of the injuries accounting for 38,1% of them, followed by baseball, basketball, martial arts, and winter sports, were the most frequent causes of the injuries. Nasal bone fractures were the most frequent fractures at 54,2% in all sports and the most common fracture overall. (Hwang et al. 2009)

5. Discussion:

We examined the various mechanisms behind nasal injuries in youth sports, exploring how different activities contribute to the risk of injury. Understanding the specific factors contributing to these injuries across different activities and age groups facilitates the development of successful prevention measures.

The primary cause of nasal injuries in soccer happens due to an opponent's head striking the victim's nose. In contrast, elbows to the nose frequently cause injuries in basketball. In baseball and softball, a common injury mechanism is a ball that has been tipped or misjudged. In tackle football, where helmets are mandatory, a notable number of injuries (5 out of 12) are due to ill-fitting helmets (Cannon et al. 2011).

To provide further information about soccer-related injuries, the most common causes are direct head-on collisions (39.0%), elbow contact (27.0%), and head or face kicks (13.4%). The soccer ball itself, contact with the ground, and the lower extremities of other players are additional risks of injury (Bobian et al. 2016).

Compared to other age groups, bats are the major mechanism responsible for most injuries in children under five years of age. On the other hand, injuries from balls account for 68.2% to 88.0% of cases in children over nine years old (Cranial 2015).

According to Guys (Guys et al. 2018), the most common causes of swimming-related injuries are collisions with other swimmers (37%) and interactions with the pool's floor or walls when diving (19%).

All things considered, when it comes to different sports, getting hit by a ball is the most common way that people get nose injuries, especially when they are actively playing with the ball (MacIsaac et al. 2013). Golf clubs (63.2%) are the most common cause of injuries in golf, followed by golf balls (23.7%) and falls (11.4%).

Remarkably, a substantial portion of injuries are from being struck by a friend or family member swinging a club; this is especially true for children, whose golf clubs account for 82.5% of injuries (Oska et al. 2020).

The mechanisms of nasal injuries in children vary significantly across different sports, highlighting the need for tailored preventive measures. In soccer, basketball, and baseball, direct physical contact with other players or sports equipment is a primary cause of injury, while in sports like swimming and golf, environmental factors and accidental impacts play a more significant role. Notably, the high incidence of nasal injuries caused by ill-fitting helmets in tackle football emphasizes the importance of proper equipment fitting and maintenance. Understanding these mechanisms allows for the development of sport-specific strategies, such as protective gear improvements and targeted safety protocols, to reduce the occurrence of nasal injuries in youth sports.

6. Diagnosis:

Childhood nasal injuries are common, and their importance is typically disregarded or undervalued. Even an expert observer may find it difficult to assess the extent of the trauma. (East and O'Donaghue 1987) Therefore, it is critical to have a complete medical history when a young patient presents with a nasal trauma, particularly if there is a possibility of child abuse. Between 30 and 50 percent of maltreated children are thought to have facial injuries. Examining the nasal cavity is a simple skill that requires only a source of light and lifting the tip of the nose. When performing an external nasal examination, the bridge should be gently palpated for asymmetry. (East and O'Donaghue 1987) A C-shaped nose and/or a palpable distortion of the nasal bones are the basis for diagnosing a nasal fracture following the use of a decongestant spray. A swollen and painful septum, a cerebrospinal fluid rhinorrhea, any intranasal lacerations, and a septal hematoma are also being checked for. (Cannon et al. 2011) Bluish discoloration in the nasal bridge is the most typical clinical sign in children with nasal fractures. (Basheeth et al. 2015) However, for the following reasons, nasal bone fractures in children are often overlooked:

1) it can be challenging to conduct a physical examination in an anxious child who just sustained a recent trauma;
2) it is possible that robust bone crepitation is absent;
3) oedema, which appears sooner than in adults, might mask the deviation of the nose dorsum;

4) fractures are of greenstick type which might be easily missed with little external changes (Kim et al. 2012; East and O'Donaghue 1987)

For those reasons, a normal radiographic evaluation might not be sufficient. Nasal cartilaginous structures may also mask nasal fractures. Since septal fractures are frequent, a CT scan is necessary to rule out a rare but possible condition called a septal hematoma. A septal hematoma is a collection of subperiosteal hyperaccumulating fluid that causes the nasal septum to thicken or bulge on CT images. These lesions are typically found during the initial clinical examination and promptly drained to avoid septal avascular necrosis, superinfection, and subsequent growth disturbances. (Galiano and Alcala 2008).

An accurate diagnosis is especially important because the paediatric airway is more flexible and thinner, it is, therefore, crucial to maintain a satisfactory air passage. Furthermore, since newborns breathe through solely their noses, any trauma that blocks the nasal airway, which would not be life-threatening for an adult, might cause serious feeding difficulties or even respiratory collapse in a baby. (Tolley et al. 2023)

7. Management:

While the management of nasal fractures in adults can wait up to ten days, children should receive treatment for these injuries within four days. (East and O'Donaghue 1987) Unless airway functionality is impaired, urgent closed reduction may not be necessary in a nasal trauma resulting in a deformed nose. If the attending physician has received training in closed nasal fracture reduction, it could be preferable to try it prior to the appearance of swelling. An experienced plastic surgeon should reevaluate a severe nasal fracture that was treated by closed reduction within three to five days of the event. In order to assess whether nasal septum abnormalities are present at this time, another intranasal examination might be done. (Hwang 2020) If there is significant acute edema, the reduction should be postponed for at least three to five days. In order to reduce swelling, the patient is advised to keep the head of the bed raised during this time and to apply cold packs for the first 24 hours. Repositioning the septum directly is the ultimate treatment if the edema has subsided and septal fractures are visible. (Derosiers 2011)

Closed reduction is used to treat almost 95% of nasal bone fractures (Kim et al. 2012). It can be performed under regional nerve blocks in children over 6 years old (Derosiers 2011) or under general anaesthesia for younger and more anxious patients to restore the nose to its natural look and maintain a sufficient airway if they are discovered early**.** (East and O'Donaghue 1987) When treating a nasal fracture, the basic strategy is to reduce the bony nasal pyramid first, then reduce and stabilise the septum. This should be done within 3 to 5 days to allow for swelling to go down, but no later than 7 to 10 days because children heal more quickly and the fractured segments may become harder to mobilise after that time. (Tom 2019) A combination of intranasal instrument pressure and external digital pressure can be used to treat the fracture. The doctor's focus should shift to using the Asch forceps or Boise retractor to provide blunt pressure to straighten the septum once the nasal bones have been taken care of. The surgeon must exercise caution to avoid pushing the instrument too far. A splint should be used for any reduced closed nasal fracture. Perception by patients is crucial, because it is quite rare that a closed reduction will completely restore the nasal external look. The restoration of the functionality is the main objective. It is important for all patients to know that they have the option to choose to have a delayed open reduction and rhinoplasty in the future for aesthetic purposes. (Derosiers 2011)

The usual indications for paediatric open septorhinoplasty are conditions such as sleep apnea, persistent refractory sinus illness, severe nasal obstruction, chronic mouth breathing and badly displaced fractures (Tom 2019; Tolley et al. 2023) When using open procedures, it is important to exercise caution and prioritise repositioning over removing skeletal parts to prevent harm to growth centres. (Hwang 2020) Surgical care following diagnosis is also a contentious topic since disrupting the nasal growth centres can have a major impact on the development of the nose and mid-face in the future. (Hojjat et al. 2016)

Reconstructive measures for the septum that are carried out months or years after an injury are unlikely to yield positive results. Children's nasal injuries cannot be avoided. Therefore, it's critical to take all necessary steps to reduce the malformations they create. Early intervention can prevent the need for numerous challenging nasal reconstructions and time-consuming submucous resections. (East and O'Donaghue 1987) A childhood injury often results in posttraumatic nasal deformity, which many patients may not notice until they are adults. At that time, formal open septorhinoplasty can be performed in any situation without running the risk of impairing underlying growth. (Tolley et al. 2023)

Individuals who sustain solely a nasal contusion can get back to their regular activities right away. Depending on the type of activity, patients with nose fractures should be recommended to use caution for

approximately six weeks. It is often recommended that athletes who have surgery and a concurrent septal injury wait at least a few weeks before playing again. When returning to their sport or activity after an accident, and particularly after surgery, which suggests a more serious injury, the patient may need to wear a splint, shield, or other form of protective gear. The likelihood of a nasal re-injury can be reduced by wearing such protection. (Cannon et al. 2011)

8. Prevention:

Facial bone fractures make up a significant portion of sports-related injuries; in wrestling, for example, they account for 20% of all facial trauma cases. This high rate highlights how vital it is for clinicians to educate young athletes about the importance of wearing appropriate protective gear, such as mouthguards and facemasks, from an early age. Currently, regulations require wrestlers to wear headgear that protects only the ears, with facemasks permitted solely under special circumstances, like a prior facial fracture. Extending the mandate for facemasks to all young wrestlers, particularly those under 19 years old, an age group that almost 90% of facial injuries occur in, could substantially reduce these injury rates (Hojjat et al. 2016).

Baseball's popularity among young people has led to major safety improvements in the equipment used in the game. To enhance safety, innovations including mouth guards, breakaway bases, helmets with face shields, and low-impact baseballs have been introduced. However, according to Little League rules as of 2008, only breakaway bases are required, leaving other potentially protective items as optional (Carniol et al. 2015).

Epidemiological data from 2010 to 2014 show a decrease in head injuries associated in cycling, most likely as a result of helmet-use-promoting legislation. This trend was observed in Alberta where laws led to a marked reduction in head injuries among child cyclists. Despite this, the same level of protection does not extend to the face, suggesting a gap in safety that is not filled by the helmets that are on the market today. According to studies, helmets are less effective at preventing lower facial injuries but do a significant job of protecting the upper and midface. There is a need to redesign helmets to offer better facial protection (Svinder 2015).

Aquatic sports prevention strategies focus on teaching proper diving technique, educating athletes about not jumping or diving into shallow water, and having qualified lifeguards oversee them. The goal of these actions is to lessen orthopedic, spinal cord, and face injuries brought on by swimming and diving (Guys et al. 2018).

Nasal shields, which are made to resist deformation and distribute impact energy, provide an extra degree of protection for sports like basketball and soccer and guard against nasal injuries (MacIsaac et al. 2013).

Young players in particular have special difficulties since they may not be as aware of their surroundings as more experienced players, which puts them at higher risk of injury. Risks can be reduced by teaching young golfers about safety procedures and providing enough supervision, particularly as a large portion of pediatric golf injuries happen to bystanders (Oska et al. 2020).

In sports, post-operative care is crucial. For instance, athletes returning to contact sports after nose surgery are advised to wear face guards for a minimum of one month after the treatment in order to ensure complete healing and prevent re-injury. This procedure emphasises the necessity of ongoing safety even following a first recovery (Morita et al. 2007).

All sports consistently need to assess and improve the protective measures in place to maintain athlete safety across all levels and types of play, even though conventional protective gear like that used in hockey and football has been successful in minimising nasal fractures (Xiao et al. 2022).

9. Complications:

Many young patients continue to show nasal abnormalities as they grow, even after being treated with closed nasal reduction. The research indicates that the prevalence of chronic nasal deformity or obstruction following closed reduction may range from 11% to 41% in paediatric patients, which proves that the treatment with a septorhinoplasty is very crucial at skeletal maturity. Parents should be aware of the risk of complications appearing with time and they are advised to remain alert for any new symptoms or deformities. (Tolley et al. 2023)

Potential short-term and long-term complications that can occur as a result of nasal bone fractures are septal hematomas, malunion of the bones, synechiae that can lead to nasal deformities or septal deviation, which could cause nasal airway obstruction. (Desrosiers and Thaller 2011)

Blood that becomes stuck may form fibrosis and a hematoma, which may result in acute nasal airway blockage. A septal hematoma or abscess formation is indicated by swelling and blue discoloration, which calls for an immediate referral to the ear, nose, and throat. An untreated septal abscess might result in cavernous sinus thrombosis or meningitis. The hematoma, if left untreated, presses against the septum, severing the cartilage from the underlying nourishment. Necrosis follows, which eventually causes a perforation and

cartilage loss. To check for recurrence, small septal hematomas might be aspirated during a second inspection. Bigger hematomas require systemic antibiotic treatment, extensive drainage, and packing with iodoform gauze. (Derosiers 2011; East and O'Donaghue 1987)

Nasal deformities can form as a consequence of synechiae, septal hematoma or abnormal position in which the fractured nasal bones are rejoined. Synechiae may develop if septal and turbinate lacerations are left close together and heal at the same time. Saddle nose deformity can result from a septal hematoma, whereas nasal deviation may be caused by a malunion of the nasal bones. (Desrosiers and Thaller 2011) In around 15% of paediatric patients with facial fractures, there is a growth disturbance owing to a severe fracture (particularly a fracture through a susceptible structure like the nasal septum or suture lines). Given that older children's facial skeleton is nearly fully developed, the risk is lower. Either an undergrowth or an overgrowth of bone can cause asymmetry. (Alcalá-Galiano et al. 2008) Nasal deviation and dorsal hump may be more frequently observed if the cartilaginous part of the nasoseptovomeral region is damaged, since this can cause a considerable disruption in growth. Isolated nasal bone fractures cause less disruption in growth. (MacIsaac et al. 2013) The percentage of cases where nasal bone fractures resulted in nasal deformities or septal deviation reached around 10% after treatment. China and Korea have a much higher rate of deformities than the United States. (Hwang et al. 2017) Another research indicates that the prevalence of chronic nasal deformity or obstruction following closed reduction of fractured nasal bones may range from 11% to 41% in paediatric population. (Tolley et al. 2023)

Nasal obstructions following nasal bone fractures were reported in 10.5% of patients overall. Nasal obstruction was less common in patients who had been treated with open reduction than in those with closed reduction. (Hwang et al. 2017) Nasal obstruction can develop not only as a result of the nasal bone fracture itself but also as a result of the complication of that fracture like septal abscess or hematoma. (Smith and Ishman 2018) Septal deviation can also result in nasal obstruction which may lead to obstructive sleep apnea. (Alghamdi et al. 2022) The symptoms of obstructive sleep apnea syndrome include snoring, breathing pauses during sleep, and excessive daytime sleepiness. A complete halt of oronasal outflow despite diaphragmatic movement for at least 10 seconds and accompanied by at least a 4% decline in oxygen saturation is commonly used to characterise an obstructive apnea. (Kushida et al. 1997) In a study conducted in 2022 by Yeom et al. showed that the nasal septal deviation group had a 4.39-fold higher prevalence of obstructive sleep apnea than the control group. (Yeom et al. 2022) The exact nature of the relationship between nasal obstruction and obstructive sleep apnea syndrome has not yet been fully defined despite the numerous research that have found this association. It is known that self-reported sleep quality may be enhanced by reducing nasal resistance, whether via medication, surgery, or the use of nasal dilators. Even though there isn't enough data to support nasal surgery as a stand-alone treatment for moderate-to-severe obstructive sleep apnea syndrome, surgical techniques that increase nasal patency can help patients with the condition by relieving the symptoms of simple snoring and by treating them with multiple levels of surgery. (Michels et al. 2014) Consequently, septoplasty is regarded as one of the ways to greatly reduce obstructive sleep apnea, especially in those who cannot handle CPAP treatment. (Yeom et al. 2022; + Michels et al. 2014)

An intriguing discovery revealed that 37.7% of patients suffering from nasal bone fractures reported experiencing difficulties with their smell. Anatomically, the olfactory neuroepithelium is dispersed throughout the superior nasal cavity, situated between the bilateral superior turbinate medial surface and the septum. Damage to the superior or supreme nasal turbinate during reduction of the broken nasal bone may be the cause of the high occurrence of olfactory disturbances. (Hwang 2017)

10. Conclusions:

The limitations and difficulty of conducting a review of nasal bone fractures in paediatric population is the scarcity of research focusing solely on children’s injuries to the nose, whereas most of the research combines both adult and paediatric patients into one cohort further complicating the extraction of specific data.

We come to the conclusion that the majority of nose fractures sustained in sports are not preventable, so it's critical to reduce the deformities they cause as much as possible. (Cannon et al. 2011; East and O'Donaghue 1987) Baseball and basketball have been proven to produce the most nasal fractures in youths in the United States. (Xiao et al. 2022) Many studies proved that fractures are more common in teenagers than in younger children. Teenagers' nasal structure is more prominent than that of younger children, which renders them more vulnerable to harm. (Escalona and Okamura 2024) An explanation in regards to water sports could be because older kids are more inclined to try riskier dives or do more difficult swimming techniques, like blind flip turns, which puts them at risk for high-speed collisions with the pool's floor or wall. (Guys et al. 2018) Although the

number of facial fractures in golf may not be as high as in other conventionally recognised "high-impact sports", like baseball and football, paediatric patients are disproportionately more affected, and the morbidity is higher. The risk of fracture should be understood by parents and kids who play the sport. Children who use golf equipment, especially golf clubs, should be properly supervised and trained in safety and technique in order to reduce the risk. (Oska et al. 2020)

A ten-year-long analysis, from 2009 to 2018, the authors observed a 47% drop in the occurrence of isolated nasal bone fractures connected to sports during that time. The popularity of non-athletic forms of recreation, such as video games, has increased, which may be a potential explanation of such a decrease. With the game industry's revenue nearly doubling from $76.5 billion to $151.9 billion between 2013 and 2019, many sports shifted from outdoors to e-sport. Increasing protective gear could be another factor contributing to the decline in nasal bone fractures in sports. Similar declining patterns have been observed in sports like baseball and hockey, which have linked the rising use of protective gear like helmets and face shields to declining tendencies in cases of facial damage. Furthermore, certain sports are shifting away from heavier contact plays, which carry a high risk of nasal bone fracture. For example, in basketball, the number of fouls committed has steadily declined over time in the NBA. (Xiao et al. 2022) It is therefore believed that declining sports participation, the usage of face masks in sports, and regulatory changes, were contributing factors to this decline in nasal injuries. (Okumura 2024) Even though playing sports has many advantages, research on paediatric facial trauma and related fractures must continue in order to create safety gear and procedures that reduce the hazards connected with these activities. (Cepeda et al. 2021)

Overall, nasal bone fractures in children occur quite frequently. A thorough history and physical examination, as well as knowledge of the underlying structural anatomy, are necessary for successful care. (Desrosiers and Thaller 2011) Early intervention can prevent the need for numerous challenging nasal reconstructions and time-consuming submucous resections. (East and O'Donaghue 1987) In comparison to a late closed reduction, an early closed reduction of a nasal bone fracture produced better outcomes in terms of postoperative deformity, malalignment, irregularity of the arch, displacement of the bone, and olfactory abnormalities. (Raghvi et al. 2023) Before surgery, healthcare professionals should advise patients of the "rule of 10" about nasal bone fractures, which states that 10% of patients would likely experience deformity, septal deviation, or nasal obstruction. When performing reduction surgery, surgeons need to be extremely cautious to avoid the olfactory mucosa. (Xiao et al. 2022) Patients with significant damage to their septum and nasal bones were advised that a rhinoplasty could eventually be necessary to repair the outward abnormality. (Raghvi et al. 2023) Lack of long-term follow-up in subjects undergoing both surgery and conservative treatment is the main limitation of the available literature surrounding the subject of nasal bone fractures in the paediatric population. (Kim et al. 2022)

There is not enough data to conclude whether or not children with nasal trauma are more likely to develop sleep apnea due to lack of long-term follow-up of these patients. It is proven by multiple research that nasal obstruction may occur as a result of nasal bone fracture as well as septal deformation. Those two complications may in return contribute to the development of obstructive sleep apnea.The precise mechanism and magnitude of the influence of nasal obstruction on upper airway collapse in obstructive sleep apnea syndrome remain unclear, though. (Kushida et al. 1997) Hopefully, further research will shed more light on this significant factor in obstructive sleep apnea condition.

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