International Journal of **Health Science**

DIAGNOSTIC AND THERAPEUTIC APPROACHES IN THE MANAGEMENT OF NASAL FRACTURES: CHALLENGES AND TECHNOLOGICAL ADVANCES

Maraiza Carneiro
Universidade Anhanguera (Uniderp)
Campo Grande/MS
https://orcid.org/0009-0000-1808-8301

Ramana Scardua Jonas
Faculdade Brasileira de Cachoeiro (Univix)
Cachoeiro de Itepemirim/ES
https://orcid.org/0009-0002-2775-0031

Camila Bacry Ribeiro
Faculdade Metropolitana de Manaus
(FAMETRO), Manaus/ AM
https://orcid.org/0009-0002-1024-9312

Pedro Marcos Pivetta De Souza
Universidade Santo Amaro (UNISA)
São Paulo/ SP
https://orcid.org/0000-0001-9822-7710

Nisrin Hayssam Taghlebi
Universidade Cidade de São Paulo (UNICID)
São Paulo/ SP
https://orcid.org/0009-0005-3508-6283

Emily Porto Martins
Centro Universitário de Valença (UNIFAA)
Valença/ RJ
https://orcid.org/0009-0008-8218-3053

Katharyne Cardoso Martins
Centro Universitário de Valença (UNIFAA)
Valença/ RJ
https://orcid.org/0009-0008-3277-2351

Eduarda Tartaro
Universidad Maria Auxiliadora (UMAX)
Asunción/ PY
https://orcid.org/0009-0007-4984-0042

Victória Zambon Moscon
Faculdade Multivix (MULTIVIX)
Vitória/ ES
https://orcid.org/0009-0008-1919-5561

Maíra Taliberti
Universidade do Oeste Paulista (UNOESTE)
Jaú/ SP
https://orcid.org/0009-0001-3953-8663

Thaiz Geovana Bezerra
Universidade do Oeste Paulista (UNOESTE)
Jaú/ SP
https://orcid.org/0000-0002-2525-4424

Abstract: Objective: To analyze the epidemiological factors, diagnostic options and most effective therapeutic approaches in the management of nasal trauma, with a focus on preventing functional and aesthetic sequelae. **Methodology**: Bibliographic review carried out in the PubMed - MEDLINE database, using the search terms "nasal", "nose", "fracture" and their derivatives, combined with Boolean AND operators. We selected 12 articles published between 2010 and 2024 that directly addressed the proposed topic, including systematic reviews, meta-analyses, observational and experimental studies. **Review**: Nasal fractures are highly prevalent, affecting mainly young men due to traffic accidents, assaults and sports activities. In children, falls are the main cause. Early diagnosis is essential, with emphasis on computed tomography (CT), considered the gold standard, and ultrasound. Treatment must be individualized, taking into account factors such as the type of anaesthesia, time of intervention and severity of the fracture. Local anesthesia is effective for less complex cases, while general anesthesia is preferable for severe fractures or in children. Emerging artificial intelligence technologies, such as deep learning (DL), have proven effective in the rapid and accurate diagnosis of minor fractures. **Final considerations:** A multidisciplinary approach is essential in the management of nasal fractures, integrating early diagnosis, appropriate interventions and effective preventive strategies. Modern diagnostic tools, such as ultrasound and artificial intelligence, have the potential to improve clinical outcomes. Further studies are needed to validate these technologies and optimize care protocols, with a view to minimizing functional and aesthetic complications and improving patients' quality of life.

Keywords: Nasal Fractures, Diagnostic Imaging, Therapeutic Approaches, Prevention of Sequelae.

INTRODUCTION

Facial fractures, particularly nasal and craniomaxillofacial fractures, represent a significant challenge in clinical practice and are the most common injuries among craniofacial trauma. These fractures can vary in severity and are often caused by traffic accidents, assaults and sporting activities. These injuries affect both adults and children. Facial fractures account for 40% to 50% of pediatric fractures. Effective management of these conditions requires accurate diagnosis and timely interventions to prevent complications. Lack of adequate treatment can lead to long-term cosmetic and functional deformities (Hassankhani *et al.*, 2024).

Among facial fractures, craniomaxillofacial fractures, such as those involving the frontal sinus and naso-orbital-ethmoidal region, are more complex to diagnose and treat. These injuries are often associated with high-energy trauma and serious complications such as mucocele, meningitis and severe deformities. However, the management of these fractures is a controversial subject, with the evidence limited mainly to case reports and small studies. This situation emphasizes the need for further research to explore better therapeutic practices (Pawar; Rhee, 2014).

In the diagnosis of pediatric nasal fractures, technologies such as ultrasound have been investigated as viable alternatives. Traditional methods, such as X-rays and CT scans, have limitations, including radiation exposure and high costs, making ultrasound a potentially safer and more accessible option. However, the literature on the diagnostic efficacy of ultrasound is still limited, and its comparison with conventional methods requires more robust investigations (Hassankhani *et al.*, 2024).

After the COVID-19 pandemic, telemedicine emerged as a viable alternative, especially in otorhinolaryngology, which continues today. The practice faces limitations, as many diagnostic tests and therapeutic interventions in this area require physical contact and specialized instrumentation. Despite this, telemedicine has shown potential, with remote video-otoscopy standing out as a promising tool. More comprehensive studies are needed to determine its effectiveness in specific clinical practices, such as in the diagnosis and follow-up of facial and nasal fractures (Moentmann *et al.*, 2023; Hwang; Ki; Ko, 2017).

This study aims to evaluate the epidemiology, diagnostic methods and therapeutic options for facial trauma. With an emphasis on nasal fractures, cartilaginous injuries and associated complications, in an attempt to identify the most effective approaches to minimize functional and aesthetic sequelae. In addition, the role of emerging technologies such as ultrasound and telemedicine in the management and monitoring of these injuries will be explored.

METHODOLOGY

This is a literature review, developed according to the criteria of the PVO strategy (*Population or research problem, Variables and Outcome*), used to formulate the guiding research question: "What are the main epidemiological factors, pathophysiological mechanisms and diagnostic and treatment options in the management of nasal trauma, and how can current therapeutic approaches prevent functional and aesthetic sequelae in patients with nasal fractures and cartilaginous lesions?"

The searches were carried out in the Pub-Med - MEDLINE (Medical Literature Analysis and Retrieval System Online) database, using specific terms combined with the Boolean operators "AND". The search strategy involved terms related to nasal fractures and diagnostic methods, including keywords such as "nasal", "nose", "fracture" and their derivatives. Initially, 117 articles were identified, which underwent a careful analysis according

to the pre-established inclusion and exclusion criteria. The inclusion criteria considered publications in English, from 2010 to 2024, which directly addressed the proposed themes, including systematic reviews, meta-analyses, observational and experimental studies. Duplicate articles were excluded, as well as those available only in abstract form, which did not directly address the subject under investigation or which did not meet the inclusion criteria. After screening the studies, 12 articles were selected to make up this literature review. These studies were critically analyzed in order to provide a comprehensive understanding of the epidemiological factors, pathophysiological mechanisms and diagnostic and therapeutic options for the management of nasal trauma and the prevention of functional and aesthetic sequelae.

DISCUSSION

According to Hwang *et al.* (2017), the nose, due to its prominent position on the face, is highly susceptible to fractures. In addition to its aesthetic functions, the nose plays sensory, respiratory and immunological roles, and is also involved in speech projection. Nasal fractures are more prevalent in men, especially related to traffic accidents involving vehicles, motorcycles and bicycles. In females, fractures are associated to a lesser extent with falls, accidental trauma and physical violence (Davari; Pirzadeh; Sattari, 2023).

Davari, Pirzadeh and Sattari (2023) observed that the prevalence of nasal trauma occurs predominantly between the second and third decades of life, with an average age of 26 years. Although less frequent, the pediatric population also has significant cases of nasal fractures, the diagnosis in this age group is more challenging due to the predominance of the cartilaginous composition of the nose in children (Navaratnam *et al.*, 2019).

Goh *et al.* (2024) analyzed naso-orbito-ethmoidal (NOE) fractures and observed significant differences in trauma caused by car accidents. Adults with an average age of 29 accounted for 79.2% of cases, while children with an average age of 10.2 accounted for 50% of injuries. Children had a higher incidence of complications (65.9%) compared to adults (28.4%), including midface deformities (9.2%) and growth-related problems.

Allareddy *et al.* (2014) investigated facial fractures in children and adolescents treated in emergency departments, focusing on associated demographic factors. Nasal fractures accounted for around 60% of cases, highlighting the anatomical vulnerability of this region and its exposure to direct trauma. Younger children were more susceptible to falls and bicycle accidents, while adolescents face risks associated with assaults and traffic accidents. The study identified a male predominance, especially in violence-related injuries, while women were more frequently affected by falls and transportation accidents. In addition, socioeconomic factors, such as low family income, were associated with a higher risk of facial fractures, reflecting inequalities in access to prevention and safety. These findings reinforce the need for specific preventive strategies for different age groups and social contexts.

According to Hwang, Jung and Kim (2018), radiography is the most traditional method for diagnosing nasal fractures, due to its high availability and low cost, but it has low sensitivity for detecting smaller fractures. Ultrasound has emerged as a non-invasive and radiation-free alternative, especially in children, although it depends on the skill of the operator. Ragavan *et al.* (2019) states that computed tomography is the most accurate method for diagnosing nasal fractures of different sizes, especially in pediatric patients. Despite this, ultrasound has emerged as a promising alternative because it is fast, inexpensive and non-ionizing, as well

as showing superiority over plain radiography for identifying fractures. However, the available evidence on the effectiveness of ultrasound as a diagnostic tool is still limited. Computed tomography, considered the gold standard, offers high sensitivity and specificity for complex fractures, but is expensive and has greater exposure to radiation.

The study by Nam *et al.* (2022) evaluated the performance of deep learning (DL) algorithms, based on convolutional neural networks (CNNs), in diagnosing nasal fractures from bilateral plain radiographs, comparing them with experienced radiologists. The results showed excellent accuracy (AUC: 0.931 in internal testing; AUC: 0.857 in external testing) and sensitivity of 83.1%, highlighting the potential of this technology in scenarios where access to computed tomography (CT) is limited. The use of DL proved to be a complementary diagnostic tool, particularly in smaller fractures or when diagnosis time is critical, preventing sequelae such as chronic nasal obstruction and permanent aesthetic deformities. Despite the promising results, the study emphasizes the need for validation in diverse cohorts, considering limitations such as small sample size and anatomical differences between populations.

Al-Moraissi and Ellis III (2015), highlighted three main variables in the management of nasal fractures: the type of anesthesia, the length of treatment and the surgical approach chosen. The patient's profile plays a crucial role in the therapeutic decision. For example, in children, local anesthesia is often unfeasible and general anesthesia is necessary to allow for safer and less traumatic interventions. Other important factors include the surgeon's experience, the extent of the trauma and the length of hospital stay. The study concluded that local anesthesia is a safer, more effective and more economical option for the hospital in less complex cases. General anesthesia, on the other hand, is indicated for more serious traumas and allows for more invasive surgical manipulation, reduces post-operative pain and preserves nasal function, an essential aspect for future surgeries.

Among the different therapeutic approaches for frontal sinus fractures (FSFs), patients treated with clinical monitoring and computed tomography had a lower complication rate (7%) compared to those treated with cranialization (11%). Non-surgical treatments reduced the incidence of complications by 2.1 times compared to surgical interventions, demonstrating efficacy in fractures of lesser severity (Al-Moraissi *et al.*, 2021). This study reveals the importance of individualized treatments, considering the severity of the fracture and the structural integrity of the nasofrontal outflow tract (NFOT), in order to minimize complications and optimize results.

This highlights the need for early primary repair, since delayed repair (after two weeks) was associated with less favorable outcomes in both groups. In adults, invasive approaches such as bone grafts were more common, while in children the use of transnasal canthopexy and resorbable plates predominated, due to the preservation of growing structures (Goh *et al*., 2024).

Wishwanath *et al.* (2023) analyzed the effectiveness of antibiotic prophylaxis in preventing infections in nasal fractures treated by closed reduction. Although antibiotics were widely prescribed (more than 50%), the results showed no significant difference in infection rates between patients who did and did not receive prophylactic treatment. The study suggests that a therapeutic approach, including adequate irrigation and careful management of the lesions, may be more effective in preventing infections than the indiscriminate use of antibiotics. Additionally, septal hematomas were identified as a relevant risk factor, with the prophylactic use of antibiotics proving be-

neficial in these cases. However, the authors warn of the risks associated with the excessive use of antibiotics, including antimicrobial resistance and adverse reactions, reinforcing the importance of a careful approach.

FINAL CONSIDERATIONS

Nasal fractures are prevalent due to their anatomical vulnerability and prominent location, affecting mainly young men and children in specific contexts. Their diagnosis has evolved with alternatives such as ultrasound and deep learning algorithms, complementing computed tomography. Early and individualized management, taking into account severity, patient profile and careful use of antibiotics, is essential to minimize complications and optimize aesthetic and functional outcomes. Individualized therapeutic management, which takes into account factors such as the type of anesthesia, time of intervention and complexity of the fracture, is essential to optimize clinical results. Prevention, early diagnosis and appropriate treatment remain fundamental to minimizing functional and aesthetic sequelae, as well as improving the quality of life of affected patients. Despite the advances, gaps remain in the literature, especially in the pediatric context and in the use of new technologies, highlighting the need for more research to strengthen evidence-based clinical care.

REFERENCES

ALLAREDDY, Veerasathpurush *et al*. Emergency department visits with facial fractures among children and adolescents: an analysis of profile and predictors of causes of injuries. **Journal of Oral and Maxillofacial Surgery**, v. 72, n. 9, p. 1756-1765, 2014.

AL-MORAISSI, Essam Ahmed; ALYAHYA, Abdulmalik; ELLIS, Edward. Treatment of frontal sinus fractures: a systematic review and meta-analysis. **Journal of Oral and Maxillofacial Surgery**, v. 79, n. 12, p. 2528-2536, 2021.

AL-MORAISSI, Essam Ahmed; ELLIS III, Edward. Local versus general anesthesia for the management of nasal bone fractures: a systematic review and meta-analysis. **Journal of Oral and Maxillofacial Surgery**, v. 73, n. 4, p. 606-615, 2015.

DAVARI, Rahim; PIRZADEH, Akbar; SATTARI, Fatemeh. Etiology and epidemiology of nasal bone fractures in patients referred to the otorhinolaryngology section, 2019. **International Archives of Otorhinolaryngology**, v. 27, n. 2, p. 234-239, 2023.

GOH, Elizabeth Z. *et al*. Surgical management of naso-orbito-ethmoidal fractures: a systematic review. **Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology**, 2024.

HASSANKHANI, Amir *et al*. Diagnostic utility of ultrasound in pediatric nasal bone fractures: a systematic review and meta-analysis. **Emergency Radiology**, v. 31, n. 3, p. 417-428, 2024.

HWANG, Kun; JUNG, Joon Soo; KIM, Hun. Diagnostic performance of plain film, ultrasonography, and computed tomography in nasal bone fractures: a systematic review. Plastic Surgery, v. 26, n. 4, p. 286-292, 2018.

HWANG, Kun; KI, So Jung; KO, Sang Hyun. Etiology of nasal bone fractures. **Journal of Craniofacial Surgery**, v. 28, n. 3, p. 785-788, 2017.

HWANG, Kun; YEOM, Seung Han; HWANG, Suk Hyun. Complications of nasal bone fractures. **Journal of Craniofacial Surgery**, v. 28, n. 3, p. 803-805, 2017.

MOENTMANN, Michael R.; MILLER, Ryan J.; Chung, Michael T.; YOO, George H. Using telemedicine to facilitate social distancing in otolaryngology: A systematic review. **Journal of Telemedicine and Telecare**, v. 29, n. 5, p. 331-348, 2023.

NAM, Yoonho *et al*. Diagnosis of nasal bone fractures on plain radiographs via convolutional neural networks. **Scientific Reports**, v. 12, n. 1, p. 21510, 2022.

PAWAR, Sachin S.; RHEE, John S. Frontal sinus and naso-orbital-ethmoid fractures. **JAMA facial plastic surgery**, 2014.