https://doi.org/10.48047/AFJBS.6.6.2024.6727-6738

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Investigating the agreement between clinical and radiographic examinations in the diagnosis of nasal fractures

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Article History

Volume 6, Issue 6, 2024
Received: 03 Feb 2024
Accepted: 06 Apr 2024
doi:10.48047/AFJBS.6.6.2024.6727-6738

Abstract

Background and Purpose: Nasal fractures are one of the most common injuries of the facial bones and the third most common fracture in the whole body. Clinical examination is the gold standard for diagnosing nasal fractures. However, radiography is required in challenging cases such as hematoma or edema. The present study compares radiological and clinical findings in diagnosing nasal fractures since the agreement between the examination and radiographic diagnosis has not been reported in Iran in recent years.

Methods: This cross-sectional study investigated 103 patients with nasal injuries referred to Shahid Beheshti Hospital in Babol in 2024. They were compared regarding diagnosing nasal fractures based on radiological and clinical findings. Clinical findings included tenderness, deviation, crepitus, epistaxis, and step deformity. The fracture was confirmed based on the observation of radiolucent lines and nasal bone displacement in nasal radiographs. Baseline characteristics including age, gender, and reason for referral, were also collected.

Results: According to the clinical examination, 31 (30.1%) patients were diagnosed with no fracture and 72 (69.9%) patients with nasal fracture. According to the radiographic findings, 16 (15.5%) were diagnosed with no fracture and 87 (84.5%) with nasal fracture. Generally, there was agreement in 80 cases, which was 77.7% out of 103 cases. The frequency of nasal deviation (P=0.001), the frequency of crepitus (P=0.023), and the frequency of step deformity (P=0.005) were statistically significantly higher in patients with nasal fractures diagnosed in radiographic findings.

Conclusion: According to the results, radiography is not necessary for patients referring due to nasal trauma, but it can be useful as auxiliary data in confirming the diagnosis.

Keywords: nasal bone _radiography_physical Examination _agreement

Introduction

A physician first examines patients referring to the emergency department with facial and nasal injuries to assess other areas and the presence of a septal hematoma. The physician may decide to perform radiography at his discretion (1). After clinical examination, radiography is the diagnostic method for nasal fractures. It includes lateral views to examine the nasal dorsum and occipitomental opinions focusing on the lateral nasal walls (2). Nasal fractures are one of the most common injuries to the facial bones and are the third most common fracture in the whole body (3). Nasal injuries can occur due to various reasons such as playing, sports, motor vehicle accidents, and violence (4). The diagnosis is challenging and radiography may be used to confirm or rule out a nasal fracture in cases where hematoma and edema are present in the surrounding tissues (5). The radiographic examination may also be considered for forensic purposes in midfacial injuries (6).

The use of paraclinical facilities is nowadays one of the primary components of diagnosis and treatment planning in oral and maxillofacial surgery. It is helpful in clinical examinations. One of these facilities is the examination of images obtained by X-ray. Radiography mostly includes a lateral image of the nasal bone focused on the nose dorsum and an occipitomental radiography from which the lateral walls of the nose can be evaluated. Some authors who consider it an inappropriate tool for the evaluation of nasal fractures have questioned the need for radiography. However, adequate imaging of the nasal fracture is often required due to the legal consequences arising from the cause of the nasal fracture (20). Computed tomography (CT) as the gold standard can distinguish between old and new fractures that cause confusion in the diagnosis based on physical examination and plain radiography alone. However, this standard diagnostic imaging method is limited in some cases due to its high cost or lack of availability and facilities.

Thus, finding a diagnostic power between the two conventional methods of plain radiography and clinical examination can help diagnose new fractures without the use of CT scanning (2). Standard CT scanning should be performed in a radiology clinic or hospital. The patient is placed in the supine position, and the apparatus records “flat layers” of the image in several rotations around the patient’s head. Radiation exposure is much higher than with cone beam computed tomography. Standard CT scanning may be used to check the size and placement of implants. This method helps the surgeon avoid potential complications before and after surgery (21) (22). CT generally may provide a high-resolution image of isolated nasal fractures. However, whether any imaging beyond clinical examination improves patient management is debatable (7).

A thorough understanding of nasal anatomy is the cornerstone of a good rhinoplasty. A minor change in one nasal structure can affect the rest and dramatically change the facial configuration. The external nose consists of a bony and cartilaginous framework covered by muscles, soft tissue, and skin. The face is anatomically divided into three almost equal parts: the upper third, the middle third, and the lower third. The nose is located in the middle third. The nose is divided into three parts: the upper third, the middle third, and the lower third. The upper third of the nose is the bony part of the nose. The nasal bone is its most important part.

The lower two-thirds are mostly cartilaginous. ULC is the most important part is the middle third of the nose and LLC is the most important part of the lower third of the nose (1, 2).

Due to their central location, significant prominence, and weak nature of the nasal bones, nasal bone fractures are common in facial injuries (7, 8). Untreated nasal fractures, delayed healing, traumatic edema, and hidden septal injury can cause functional and cosmetic defects (9). Delaying treatment for several days or weeks makes ideal anatomical reduction difficult or even impossible. In addition, edema worsens within two to three days after injury, making fracture healing more difficult. Untreated nasal fractures may cause nasal defects including nasal valve destruction, impaired healing, chronic sinusitis, and nasal growth disorders in children (10, 11). Concomitant septal injury can also cause further nasal instability, nasal airway obstruction, deviation, and decreased nasal tip prominence in patients who are not treated with appropriate reduction (7). The goal of treatment of fractures of the nasal-orbital-ethmoid (NOE) complex is to restore normal nasolacrimal and ocular function and to place the nasal bones and medial canthal ligaments in the proper position to ensure natural postoperative aesthetics. In these conditions, open reduction of the NOE area is mostly necessary (12).

The nose has a unique anatomical structure composed of bone, cartilage, and soft tissue (13,14). The nasal fracture detection depends on obtaining a careful history and a thorough clinical examination. Patients mostly present with a combination of epistaxis, edema, laceration, instability, crepitus, ecchymosis, and deformity. However, these clinical findings may not always be present (9). The nasal fracture management depends on the clinical presentation. Radiography is recommended in situations where cranio-maxillofacial injury is associated with high energy and leads to loss of consciousness (7). However, radiography does not necessarily alter the treatment plan. Radiography is not recommended in cases where the septal hematoma is not evident or the pain and swelling are limited to the nose bony bridge (15).

The level of agreement between clinical and radiographic fracture diagnosis has been reported to vary in the literature. In one study, radiography was reported to be a useful adjunct in confirming the nasal fracture diagnosis (4). In contrast, another study reported that diagnosis errors of nasal fractures in the emergency department are common, and these results question the efficacy of nasal radiography for diagnosing nasal fractures (16). Therefore, the level of agreement between clinical findings and radiographic findings is still not definitively known. Correct diagnosis in a short time is vital for providing a treatment plan in cases of nasal injuries (9). Radiography can be helpful in cases where clinical diagnosis is difficult. Radiography is also essential for providing the necessary forensic evidence (7).

Leapo et al. (2022) evaluated the level of using radiography in deciding on closed reduction in nasal fractures in children in the United States. They divided 117 patients with a diagnosis of nasal fractures into two groups and prepared radiographs for only one group. The results revealed that 59 surgeries were performed and an odds ratio of 0.3951 was calculated comparing the use of radiography versus no use for patients who underwent surgery. They reported that the use of radiography reduces the rate of closed-reduction surgery.

Additionally, they reported radiography is not essential for the diagnosis of nasal fracture, but it is useful as an adjunct in confirming the diagnosis and can reduce the rate of unnecessary surgery for false positive cases of nasal fracture (4). Rebours et al. (2022) investigated the diagnosis errors of nasal fractures in the emergency department. They reviewed 1,586 radiographs of nasal trauma and confirmed 782 nasal fractures based on the gold standard diagnosis. They found 369 diagnosis errors, including 28 non-diagnosis cases and 341 misdiagnosis cases. They concluded that nasal fracture diagnosis errors in the emergency department were common and that these results question the efficacy of nasal radiography for the diagnosis of nasal fractures (16).

Ojaglou et al. (2021) investigated the accuracy of radiography and ultrasonography in the assessment of nasal bone injuries in dogs. The study was conducted on 20 large breed dogs, including 14 male and six female dogs with nasal bone injuries and suspected nasal bone fractures. Statistical evaluations revealed that the accuracy and sensitivity of ultrasonography in diagnosing fractures of the nasal bridge and lateral wall of the nasal bone is higher than that of plain radiography. Ultrasonography had higher accuracy and sensitivity than clinical examination for diagnosing fractures of the nasal bridge and lateral wall of the nasal bone. In the case of fractures of the nasal bone medial wall, the accuracy and specificity of ultrasonography were also higher than that of plain radiography, and the sensitivity of both methods was the same. The accuracy of diagnosis was higher in both surgical and ultrasonographic methods in diagnosing fractures of the nasal bridge and lateral wall of the nasal bone, and the accuracy of diagnosis was higher in both surgical and clinical examination methods than in other methods in diagnosing fractures of the medial wall of the nasal bone. Based on this study, ultrasonography is considered a useful method in diagnosing nasal bone fractures, as it has higher sensitivity in diagnosing fractures of the nasal bridge and its lateral wall. It has also higher specificity in diagnosing fractures of the medial wall of the nasal bone compared to radiography. Thus, ultrasonography can be used as a noninvasive method for diagnosing nasal bone fractures in dogs compared to radiography (23).

Merza et al. (2021) evaluated the value of conventional radiography in diagnosing nasal fractures in Bahrain. They examined 260 patients and obtained radiographs. Among the 176 cases with a diagnosis of nasal fractures on clinical examination, 143 had positive radiographic findings and 33 had negative radiographic findings. Ecchymosis was also observed in only 48 patients. They concluded that radiography was beneficial as a clinical examination for patients with nasal injuries. It was also recommended for confirming the diagnosis in clinically suspicious cases and for legal issues (17). Westfall et al. (2019) evaluated the willingness to use radiography in cases of nasal bone fractures in the United States. They submitted a questionnaire to 80 ENT specialists and 60 residents. The results revealed that 33% of residents and 70% of specialists stated that the use of radiography was rarely or never applicable. The reduced willingness to use radiography was associated with the number of years of presence in the healthcare centers and the number of nasal fractures treated.

They concluded that ENT specialists rarely request radiography for the evaluation and treatment of nasal fractures. There is also a need to educate about the value of a complete clinical examination versus radiography in the evaluation of nasal fractures (7). Since the level of agreement between the examinations and radiographic methods of fracture diagnosis was not reported in recent years in Iran, the present study aims to compare radiological and clinical findings in diagnosing nasal fractures. Thus, the present study investigates the agreement between clinical examination and radiographic examination in diagnosing nasal fractures.

Materials and Methods

This cross-sectional-analytical study was conducted on patients with nasal fractures who were referred to Shahid Beheshti Hospital. The minimum sample size was determined to be 103 people based on the results of similar studies (24) conducted to investigate the agreement rate of nasal fractures by clinical examination and radiographic examination, and considering 95% accuracy (type I error $\alpha = 0.05$), acceptable error of $P = 0.1$, and $d = 0.1$. The census sampling method was used in this study, and patients whose medical records were incomplete were excluded from the study. The demographic characteristics of the patients, including age and gender were extracted from their medical records using a designed form and entered into an Excel data sheet. The reasons for referral were also divided into the categories of fights, falls from height, accidents, exercise, and unknown, and were recorded.

Clinical findings including ecchymosis, crepitus, deformity, septal hematoma, and finally the diagnosis of fracture or non-fracture were extracted from the patient's medical records and recorded in a designed form. The external nasal deformity was diagnosed in terms of nasal or septal deviation by examining the nose dorsum from the frontal, bird's eye, and worm's eye views. The nose dorsum and lateral wall of the nose were evaluated by palpation for the presence of step deformities and crepitus. The step was presented as a step and crepitus was presented as bone displacement. Intranasal examinations were performed using speculum, lighting, and suction to assess the condition of the cartilaginous septum and to rule out or confirm the presence of septal hematoma and epistaxis. This information was recorded in a designed form. The radiographs obtained in the patient records were reviewed in collaboration with a radiologist and examined for fractures. Fracture was confirmed based on observation of radiolucent lines and nasal bone displacement in nasal radiography and the results of radiographic examination were recorded in the designed form. The measurement tool validity in this study (checklist) was examined by several trained individuals.

Finally, the data were entered into Excel software after collection to prepare for statistical analysis. For the statistical analysis of this study, central indices (mean, median, and mode) were used in the descriptive statistics section, and dispersion indices (variance, standard deviation, range of variation, and coefficient of variation) were used for quantitative variables and frequency, percentage, and prevalence for qualitative data. All required graphs (bar and pie charts) were drawn. In the inferential statistics section, parametric tests (t-Student, chi-square) were used to examine the study hypotheses after examining the normality

of the data. All data analysis was performed using SPSS-25 software. The significance level was considered to be $p<0.05$.

Results

According to the results, the mean age of the patients was 37.39±17.24, with the minimum age being 3 and the maximum of 87 years.

Table 1 shows the demographic information of the study subjects.

Table 1- Baseline characteristics of the 103 patients studied

Variables	frequency	Percentage of frequency
Gender		
Male	81	78.6
Female	22	21.4
Age		
30<	40	38.8
31-50	42	40.8
50≥	21	20.4
Reason for referral		
Car accidents	43	41.7
Motorcycle accidents	23	22.3
fights	18	17.5
falls	15	14.6
Occupational/ sport traumas	2	1.9
Shooting/hard object	2	1.9

Investigating the patients' baseline characteristics revealed that 78.6% of the patients were male, 40.8% were between 31 and 50 years old. Car accident was the most common reason for referral with 41.7%.

Table 2-Clinical characteristics of nasal fractures in 103 patients studied

Variables	frequency	Percentage of frequency
Tenderness	89	86.4
Deviation	46	44.7
crepitus	46	44.7
Epistaxis	73	70.9
step	39	37.9

Investigating the clinical characteristics of the patients revealed that 86.4% of patients with nasal injuries had tenderness, 44.7% had deviation, and 44.7% had crepitus. Epistaxis was also observed in 70.9% and step noses in 37.9% of patients (Table 2).

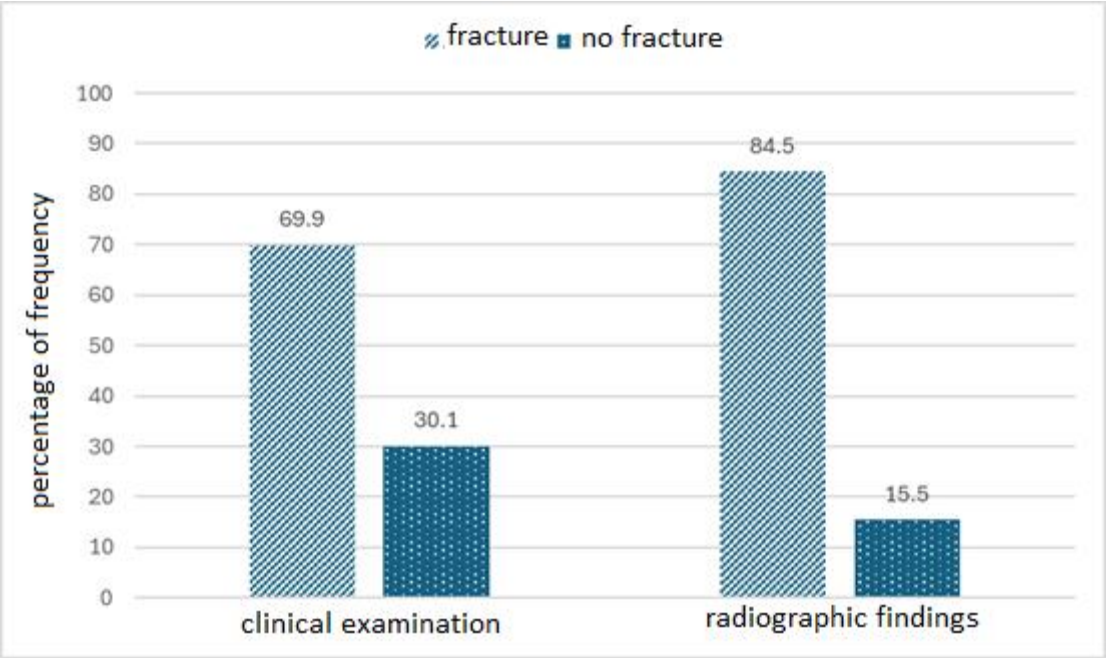


Figure 1- Distribution of nasal fracture percentage based on clinical examination and radiographic findings

Based on clinical examination, 31 patients (30.1%) were diagnosed with no fracture and 72 patients (69.9%) were diagnosed with nasal fracture. Based on radiographic findings, 16 patients (15.5%) were diagnosed with no fracture, and nasal fracture was reported in 87 patients (84.5%). Fracture match was observed in 68 cases and fracture mismatch was observed in 23 cases (P<0.001). Generally, there was agreement in 80 cases, which was 77.7% out of 103 cases (Figure 1).

Table 3- Comparison of baseline characteristics between 72 patients with fracture diagnosis based on clinical examination

variables	frequency	Percentage of frequency	P value*
Gender Male Female	 56 16	 77.8 22.2	0.001<
Age 30< 31-50 50≥	 26 31 15	 36.1 43.1 20.8	0.061
Reason for referral Car accidents	27 14	37.5 19.4	0.001<

Motorcycle	17	23.6	
accidents	10	13.9	
fights	2	2.8	
falls	2	2.8	
Occupational/ sport traumas			
Shooting/hard object			

*Using Chi-square test

The nasal fracture diagnosis was significantly higher in males than females, and this difference was reported to be statistically significant (P<0.001).

Additionally, investigating the frequency of people diagnosed with nasal fractures based on the referral reason revealed that car accidents were the most common at 37.5% and fights were in second place at 23.6%. The observed relationship was significant (P<0.001). However, the diagnosis of nasal fracture based on age groups did not show a statistically significant difference (P=0.061) (Table 3).

Table 4 Clinical characteristics of nasal fracture in 103 patients studied

Variables	Radiographic findings		P value*
	No fracture Frequency (%)	fracture Frequency (%)	
Tenderness			
no	(21.4)3	(78.6)11	0.512
yes	(14.6)13	(85.4)76	
Deviation			
no	(26.3)15	(73.7)42	0.001
yes	(2.2)1	(97.8)45	
crepitus			
no	(22.8)13	(77.2)44	0.023
yes	(6.5)3	(93.5)43	
Epistaxis			
no	(20.0)6	(80.0)24	0.422
yes	(13.7)10	(86.3)63	
Step			
no	(23.4)15	(76.6)49	0.005
yes	(2.6)1	(97.4)38	

Based on the results of Table 4, the frequency of nasal deviation (P=0.001), crepitus (P=0.023), and step deformity (P=0.005) were statistically significantly higher in patients with radiographic findings of nasal fracture.

Discussion

The nasal bones can be fractured with less force than the force that can fracture other facial bones. For this reason, they are vulnerable to a wide range of accidents and traumas (25, 26). There are different views about whether a physical examination of the nose is sufficient for diagnosis and what role radiological imaging methods play in fracture diagnosis. The present study revealed that false positive cases of a nasal fracture in radiography are high, so out of 31 cases without a fracture on clinical examination, radiography diagnosed a fracture in 19 cases (61.3%). This result suggests that radiography cannot be used as a screening method for the diagnosis of nasal fractures. Additionally, out of 72 cases of fracture diagnosis by clinical examination, 4 cases, or 5.6% were reported as no fracture on radiography. In other words, radiography alone is not as useful as clinical examination in patients with nasal injuries.

Most studies conducted to investigate the agreement between clinical and radiological examination have provided similar results. Cao et al. reported that nasal radiography had 19.6% false negative results and was not sufficient for the diagnosis of nasal bone fractures (27). Leapo et al. (28), Rebours et al (29), and Merza et al. (30) also reported that radiography was not necessary for the diagnosis of nasal fractures and could only be useful as auxiliary data along with the clinical examination. Some studies have also provided results inconsistent with those of our study. Studies by Topuz et al. (31) and Öğreden et al. (32) revealed that physical examination alone is not sufficient for diagnosis and imaging methods should also be performed.

According to the results, tenderness, epistaxis, deviation, and crepitus, respectively, were the most common clinical signs observed in patients with nasal injuries. Huang et al. (33) also concluded that the presence of the clinical signs mentioned based on physical examination is useful for diagnosing nasal fractures. The results revealed that the prevalence of nasal fractures in males was 3.7 times that of females. In the study by Rozema et al., the prevalence of fractures in males was reported to be 2 times that of females (34). The studies by Dawood et al. (35) reported a higher prevalence of nasal fractures in males. The high prevalence of nasal fractures in males may be because they usually work in hard physical jobs and are also involved in outdoor activities.

The results suggest that the prevalence of nasal fractures is much higher in those under 50 years of age. Rozema et al. reported that the prevalence of nasal fractures increases significantly in the second and third decades of life (18). In the studies by Farshchian et al. (19), the mean age of patients with nasal fractures was reported to be 25.57 and 26.8 years, respectively. It can be justified by the high level of activity, risk-taking, and violence in this age range. The results also indicate a high frequency of nasal fractures in car accidents. However, motorcycle accidents, fights, and falls from heights were also reported as major mechanisms leading to nasal fractures. Similar to our study, traffic accidents, falls, exposure

to physical violence, occupational accidents, and sports injuries have been reported in various studies as the most common causes of nasal bone fractures.

5-2- Conclusion

According to the results, performing radiography in patients with nasal trauma is not necessary and may help to make the diagnosis.

5-3- Application of results

According to the results, it is possible to decide on the reliability of clinical and radiographic findings in the diagnosis of nasal fractures.

5-4- Recommendations for future studies

• It is recommended to conduct a study to investigate the level of agreement between clinical examination and radiography in different points of nasal fractures.

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