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Moustafa Gomaa Mohamed
Otorhinolaryngology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt,
mostgomaa90@gmail.com

Ali Abdallah Abd El Rahman
Otorhinolaryngology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Ahmed Mohamed Elsheikh
Otorhinolaryngology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Mohamed Salah Elfeshawy
Diagnostic Intervention Radiology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

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ORIGINAL ARTICLE

Comparative Evaluation of Ultrasonography and Lateral Radiography in Nasal Fractures Diagnosis

Moustafa G. Mohamed [a,*], Ali A. Abd El-Rahman [a], Ahmed M. Elsheikh [a], Mohamed S. Elfeshawy [b]

[a] Department of Otorhinolaryngology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt
[b] Department of Diagnostic Intervention Radiology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***The nasal bone is the face's primary and prominent central feature, and the most frequent facial fracture occurs in this area. The rising incidence of such injuries underscores the necessity for appropriate imaging of nasal fractures based on the cause of the fracture.***

Aim: ***To compare Ultrasonography and lateral radiography in nasal fracture diagnosis.***

Patients and Methods: ***This comparative research included 70 cases selected from attendees of the Otorhinolaryngology clinics of Al Azhar University Hospitals, and the study period varied from six to twelve months.***

Results: ***No significant disparity was observed in age, sex, and body Mass Index (BMI) among people with and without fractures. Individuals with fractures exhibited a significant increase in respiratory rate (RR), heart rate (HR), and systolic blood pressure (BP) in comparison with those without fractures. There was a statistically significant high rate of agreement between fracture detection using physical examination, Ultrasonography and X-ray. Among our studied population, physical examination detected fracture in 62.9% of cases, similar to X-ray, while the US could detect fracture in 60% of cases. X-rays have a sensitivity of 100% and a specificity of 100% when predicting fractures. Ultrasonography has a sensitivity of 95% and a specificity of 100% for predicting fracture.***

Conclusion: ***This study's findings suggest that Ultrasound can be utilized as a main diagnostic tool in the vast majority of cases to identify nasal bone fractures, avoiding the unwanted dangers and problems of X-rays.***

Keywords: Ultrasonography; Lateral Radiography; Nasal Fractures

1. Introduction

Nasal fractures are often seen fractures in the context of trauma. Attempts have been made to classify these fractures, but no uni classification has yet been established. The nasal pyramid is an intricate formation comprising the bilateral nasal bones and the bilateral frontal processes of the maxillary bone.[1]

A nasal fracture can affect any nasal pyramid section. The lateral nasal walls, nasal dorsum, and nasal septum should be examined while examining a nasal pyramid fracture. The nasal fracture reduction method uses local or general anaesthetic, depending on non-compliance. The operation is performed seven days after the trauma if no further injuries occur. This surgery treats enlarged nasal septum fractures or hematomas. [2]

As an alternative to radiography, Ultrasonography is an essential and prevalent technique that does not expose the patient to additional radiation. In numerous studies, the efficacy of Ultrasonography as a diagnostic instrument for identifying "bone" fractures has been demonstrated. [3]

The most frequently employed imaging technique is nasal X-ray. Due to the false positives and the difficulty in differentiating between old and new fractures, this method cannot be relied upon to make accurate clinical judgments. Recently, Ultrasonography has been proposed as an alternative to nasal radiography due to its cost-effectiveness and reduced harmful effects, especially for expectant women and children. [4]

This work aimed to compare Ultrasonography and lateral radiography in diagnosing nasal fractures.

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* Corresponding author at: Otorhinolaryngology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt. E-mail address: mostgomaa90@gmail.com (M. G. Mohamed).

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2. Patients and methods

This comparative study included 70 patients selected from the attending Otorhinolaryngology clinics of Al Azhar University Hospitals. Samples were collected by the systematic random method. The study's duration varied between six and twelve months.

The research protocol was approved by the local ethics committee at the same time that written informed consent was obtained.

Inclusion criteria:

Age: Any Age (No age selection), both males and females were included, patients with recent nasal trauma, and accepted to give informed consent.

Exclusion criteria:

Patients with a history of old fractures, multiple fractures and previous nasal surgeries and in pregnant and young children, relative contraindication of an X-ray to avoid radiation exposure.

Patients were subjected to:

History taking that included: Mechanism of injury, previous history of nasal airway blockage, pre-existing nasal deformities, or previous history of any degree of loss of smell (hypo or anosmia), as well as prior nasal allergies, sinusitis, or nasal septal surgery, are all factors that should be considered. In addition to the investigation, a physical examination should be performed, with the nose inspected externally and internally.

Imaging:

Isolated nasal injuries did not require routine imaging. Individuals frequently attend a specialist's office with previously acquired X-rays or computed tomography scans.

Radiology:

The X-ray of the nasal bone plays a crucial role in diagnosing fractures affecting the nasal bones. A CT scan of the nose and sinuses is useful for detecting fractures affecting other facial bones and for diagnosing Lefort II and Lefort III fractures. Utilizing a 10 MHz probe in Ultrasound allows for a distinct view of the nasal bone region, making it easier to identify fractures.

Types of nasal bone fracture:

Included isolated nasal bone fracture and parts of injuries to the surrounding facial skeleton as Nasoseptal fracture, Naso-orbitoethmoid (NOE), Zygomaticomaxillary Complex Fracture, Orbital Fracture and Skull Base Fracture.

Methods

The initial radiographic investigation of every individual was carried out using lateral and Waters view X-rays, utilizing the Definium™ 646 HD* X-ray system powered by Helix™ 2.0. The reports were subsequently documented. Patients underwent sonography utilizing ESAOTE MYLAB 50 ultrasound equipment and a 10 MHz linear probe.

Fig. 1: Ultrasound shows a longitudinal view with a non-displaced fracture line

We do not do x-rays of this pregnant woman to avoid radiation exposure.

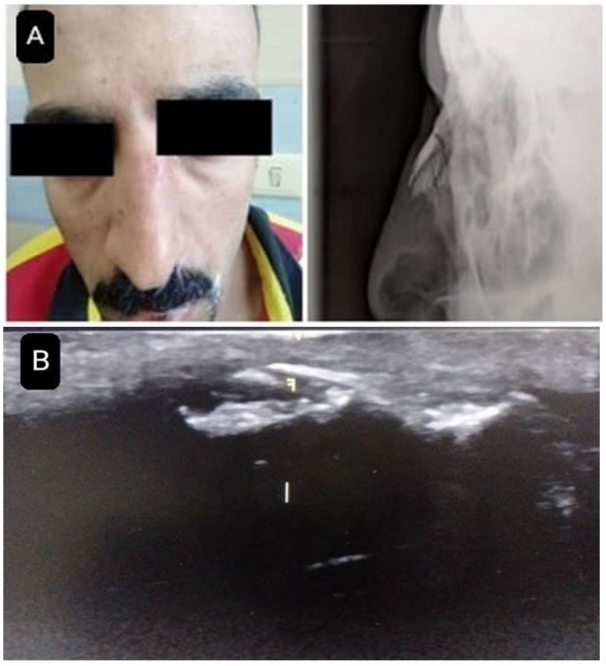

Fig. 2: A) X-ray shows right lateral nasal bone non-displaced fracture. B) Ultrasound shows cortical interruption and confirms the fracture line.

3. Results

Table 1. Comparison of demographic data of the studied population

		FRACTURE	NO FRACTURE	INDEPENDENT STUDENT T TEST/ CHI-SQUARE TEST	
		N=44	N=26	t/X2	p-value
AGE YEARS	Range	18-48	18-33	-	0.633
	Mean ± SD	27.84 ± 4.78	26.19 ± 5.03	0.480	
AGE GROUP	<30 year	28 (63.4%)	20 (76.9%)	1.339	0.247
	>30 year	16 (36.6%)	6 (23.1%)		
BMI	Range	18-39	21-39	0.599	0.553
	Mean ± SD	27.84 ± 4.78	26.99 ± 6.21		
SEX	Male	23 (52.3%)	18 (69.2%)	1.939	0.164
	Female	21 (47.7%)	8 (30.8%)		

There was no significant variation among cases with and without fracture as regard the age, sex, and BMI.

Table 2. Comparison of vital data of the studied population

BASELINE	FRACTURE N=44	NO FRACTURE N=26	INDEPENDENT STUDENT T TEST	
	Mean ± SD	Mean ± SD	t	p-value
HR (BEAT/MIN)	94.20 ± 11.41	81.58 ± 16.09	3.832	<0.0001
RR (CYCLE/MIN)	23.04 ± 5.02	18.11 ± 3.69	4.542	<0.0001
TEMPERATURE ^{0}C	37.07 ± 0.18	37.06 ± 0.16	-0.036	0.608
SBP (MMHG)	124.09 ± 9.72	118.73 ± 11.00	2.06	0.045
DBP (MMHG)	81.02 ± 6.70	78.00 ± 8.07	1.609	0.115

There was a statistically significant higher HR, RR and systolic BP in patient with fracture than those without fracture.

Table 3. Fracture detection by different methods in the studied population

			NO.= 70	
			N	%
FRACTURE DETECTION	Physical (gold standard)	Yes	44	62.9%
		No	26	37.1%
	By ultrasonography	Yes	42	60%
		No	28	40%
	By X ray	Yes	44	62.9%
		No	26	37.1%

Among our studied population physical examination which is the gold standard detect fracture in 62.9% of cases which is similar to X-ray while US could detect fracture in 60% of cases.

Table 4. Agreement analysis of fracture detection using physical examination and ultrasonography and X-ray.

SYMMETRIC MEASURES		VALUE	ASYMP. STD. ERROR[A]	APPROX. T[B]	P-VALUE.
MEASURE OF AGREEMENT	Kappa	0.940	0.042	7.877	0.000
N OF VALID CASES		70			
MEASURE OF AGREEMENT	Kappa	1.000	0.000	8.367	0.000
N OF VALID CASES		70	70		

There was a statistically significant high rate of agreement between fracture detection using physical examination, ultrasonography and X-ray.

Table 5. Sensitivity, specificity of X-ray for prediction of fracture

AREA UNDER CURVE	STD. ERROR[A]	SENSITIVITY%	SPECIFICITY%	ASYMPTOTIC 95% CONFIDENCE INTERVAL	
				Lower Bound	Upper Bound
1.000	0.000	100%	100%	1.000	1.000

This table showed that X ray has sensitivity of 100% and specificity of 100% for predicting fracture.

Table 6. Sensitivity, specificity of ultrasonography for prediction of fracture

AREA UNDER CURVE	STD. ERROR	SENSITIVITY%	SPECIFICITY%	ASYMPTOTIC 95% CONFIDENCE INTERVAL	
				Lower Bound	Upper Bound
0.977	0.019	95%	100%	0.941	1.000

This table showed that ultrasonography has sensitivity of 95% and specificity of 100% for predicting fracture.

4. Discussion

The nose is the most prominent structure of the face, and it is widely known that the nasal pyramid is the facial bone that is most frequently broken. The nasal pyramid is an intricate formation comprising the bilateral nasal bones and the bilateral frontal processes of the maxillary bone. When evaluating a nasal pyramid fracture, it is essential to focus on the lateral nasal walls, nasal dorsum, and nasal septum, as these areas are most commonly affected. The nose, the most prominent and vulnerable part of the face, is frequently affected by fractures, making nasal fractures the most commonly seen type of facial fracture. The nose is cartilaginous in early development, making fracture diagnosis difficult. [5]

CT imaging has demonstrated superior accuracy; however, it is significantly more expensive and has the inherent risks associated with radiation exposure. Ultrasound is a safe and inexpensive imaging technique that is widely accessible. It has been proven to identify nasal fractures in adults effectively. USG is a secure, uncomplicated, and easily accessible imaging technique for examining soft tissues. It is a safe, dependable imaging technique for identifying maxillofacial fractures, and it has several benefits, including being inexpensive, readily available, not exposing individuals to ionizing radiation and providing images in real-time. A prior systematic review has suggested the application of USG due to its elevated levels of sensitivity and specificity. Studies have shown comparable sensitivity and specificity among Ultrasound and CT imaging. [6]

The main results of this study were as follows:

There was no significant variation in age, sex, and BMI among patients with and without fractures. The majority of them were males.

The Tripathi et al.[3] study supported these

results, as they reported that 100 individuals with nasal bone fractures underwent sonographic and radiographic examinations during their physical assessments. Of the total individuals, 31 were female and 69 were male. The average age of the individuals was 24.7 years. Thirty-seven individuals, accounting for 37% of the total, were aged between 20 and 30. Additionally, 28 individuals (28%) fell within the 30-40 age range, while five individuals (5%) were below 20. On the other hand, seven individuals (7%) were over 50 years old, and 23 individuals (23%) belonged to the 40-50 age group. The research comprised a male youngster who was 12 years old, the youngest patient, and a male who was 60 years old, the oldest participant.

The present study showed statistically significantly higher HR, RR, and systolic BP in patients with fractures than those without fractures. Among our studied population, physical examination, which is the gold standard, detected fracture in 62.9% of cases, which is similar to X-ray, while the US could detect fracture in 60% of cases.

In addition, Topuz et al.[7] revealed that the incidence of nasal fracture detection alone by physical examination was 41%. However, it increased to 73.2% when lateral nasal radiography was used. The highest detection rate of 85.7% was achieved when physical examination and lateral nasal radiography were employed. Nasal fractures were identified in all cases using paranasal CT. The study revealed that paranasal CT scans were substantially more effective in identifying nasal fractures than physical examination and direct nasal radiographs.

Ultrasonography is a cost-effective and non-invasive technology that may effectively detect fractures in several regions of the face, including the nasal bone, orbital floor, frontal sinus anterior wall, and zygomatic fractures. Prior research has assessed the use of Ultrasonography in identifying nasal bone fractures in instances when a fracture has already been confirmed. [8]

These results showed that there is a statistically significant high rate of agreement between fracture detection using physical examination and Ultrasonography. Using the ROC curve, X-ray has a sensitivity of 100% and specificity of 100% for predicting fracture, while Ultrasonography has a sensitivity of 95% and specificity of 100% for predicting fracture.

In the research of Astaraki et al.[9], the sensitivity and specificity of the Ultrasonography were 83.33 percent and 100 percent, respectively. The exam yielded a 93.75 percent accuracy rate, a perfect score of 100% for specificity, 95% for sensitivity, and 96.88% for accuracy.

Meanwhile, Pourmoosa et al.[4] demonstrated that compared to the gold standard, physical examination, nasal X-ray sensitivity, specificity, positive predictive values, negative predictive values, and precision were all determined to be one hundred per cent. Ultrasonography showed a sensitivity of 78.13 per cent, PPV of 100 per cent, specificity of 100 per cent, NPV of 61.82 per cent, and precision of 83.85% when contrasted with physical examination, the gold standard.

Conventional radiography was the initial diagnostic step for many years. Unlike midline nasal bone injuries, conventional radiography cannot assess lateral nasal wall injuries.[10] Additionally, multiple investigations have shown that standard radiography cannot routinely evaluate nasal bone fractures.[11] Previous research demonstrated that standard radiography detects nasal bone fracture lines with 79% sensitivity. [12]

Tripathi et al.[3] revealed that Ultrasonography was used to assess all 100 individuals. 65 out of 78 individuals with a clinically confirmed nasal bone fracture exhibited a visible fracture line. While 13 individuals showed positive results for nasal bone fracture during the physical examination, the fracture line was not detectable in the Ultrasonography. LR-, LR+, PPV, and NPV were higher in Ultrasound than in radiography. The LR^- of Ultrasonography was lower than radiography. Sonography's LR+ for nasal bone fracture diagnosis was 65.20 [9.28-390.10], indicating a solid increase in fracture likelihood with positive results. LR^- of sonography was 0.14 [0.10-0.21], indicating a significant to moderate decrease in fracture likelihood with negative findings. LR+ of radiography was 6.20 [2.87-6.27], indicating a slight increase in fracture likelihood in positive results, while LR^- of x-ray was 0.36 [0.21-0.42], indicating a slight decrease in potential fractures in negative results.

However, in the study of Eskandarloo[13], Ultrasound was found to be statistically superior to radiography when evaluating the lateral nasal walls. On the other hand, radiography was more accurate than Ultrasound when evaluating the nasal dorsum. The nasal pyramid was assessed using radiography and Ultrasound, and there was no significant distinction.

It is crucial to use imaging modalities for the diagnosis of nasal fractures in order to avoid deformities and chronic fractures as potential consequences. Evaluating nasal injuries often involves radiography; however, locating sidewall injuries using radiography can be challenging. [14]

The research has a limited sample size, and we have not included data on the specific type and location of nasal fractures that could be related to various outcomes.

4. Conclusion

The utilization of Ultrasound has experienced a substantial surge in both emergency medicine and intensive care. Furthermore, it has demonstrated utility in various additional pediatric emergency scenarios, including assessing dehydration levels, detecting foreign objects, evaluating the diaphragm, and identifying venous access points, all without the need for ionizing radiation. This technology can help pediatric emergency rooms identify time-sensitive critical conditions faster for diagnosis and treatment. This method can save billions of dollars annually across health systems, improving care quality and resource use. Furthermore, the findings of this study suggest that Ultrasonography can be utilized as a primary diagnostic tool in the identification of nasal bone fractures in the vast majority of cases, avoiding the unwanted dangers and problems of X-rays. This is particularly crucial for pregnant women and young children.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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