

## Comparative Evaluation of Ultrasound Against Conventional Radiography in Patients With Nasal Bone Fractures

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### Abstract

**Introduction:** Nasal bone fractures are one of the most common problems in patients who are referred to otolaryngology centers. We aimed to evaluate physical examination, sonography and conventional lateral nasal bone radiography in patients with nasal bone trauma and its relation to intra-operative findings.

**Methods:** This prospective study was performed on 200 patients with nasal trauma and those suspicious for nasal bone fracture. The results of physical examination, sonography and radiography were recorded in a check list and compared with intra-operative findings. Data were analyzed using SPSS software version 21.0 and the means of groups were compared using parametric or non-parametric tests according to the result of 1-sample K-S test for normal distribution. P-values less than 0.05 were considered statistically significant.

**Results:** Evaluation of 200 patients and their sonography revealed that the sensitivity and specificity of this method was higher than the conventional lateral nasal bone radiography. Sonography compared to physical examination in the diagnosis of dorsum and lateral nasal bone fractures had higher sensitivity and specificity. For septal fractures, the specificity of physical examination was higher and the sensitivity of both methods was the same.

**Conclusion:** Sonography with higher sensitivity and specificity is a useful method in the diagnosis of nasal bone fractures. In comparison to radiography it has no radiation; therefore, it is more useful for children and pregnant women.

### Introduction

Nose is a prominent structure of face and is more prone to fractures among other maxillofacial bones. The nasal pyramid consists of some smaller bones and appendages (1). All parts may be affected by trauma. Exercise, falling down and physical violence are the most

common mechanisms of trauma leading to nasal bone fractures. Nasal fractures are more common in males for both adult and pediatric age groups. The prevalence increases with age (2-4). Failure to recognize and treat fractures can lead to complications such as external deformities, nasal obstruction, septal perforations and

other complications such as chronic sinusitis (5). These are usually persistent and may progress in the long run. Clinical evaluation is the standard way of diagnosis for such problems; however, the occurrence of complications makes the diagnosis difficult. At this time, imaging measures can be helpful.

Simple nasal radiographies are commonly used in these cases. However, due to some false positives as well as the inability to detect old fractures from new ones, this method does not play a role in determining how to deal with nasal fractures. In recent years, ultrasound has been used to diagnose nasal and sinus pathologies (6-8). Considering the sonography non-invasive and the limitations in use of conventional radiographies in children and pregnant women, as well as easy access to ultrasound in recent years, this study was conducted with the aim of comparing the diagnostic value of ultrasound and conventional radiography in the diagnosis of nasal fractures in Besat Hospital in Hamedan.

### Material and Methods

In this cross-sectional study, all patients in each age group who were referred to the otolaryngology clinic of the Besat Hospital in Hamedan during one year and who were candidates for nasal fracture surgery were studied. The study protocol was approved by the ethical and scientific review committee of Hamedan University of Medical Sciences with the registration code number of 9404091978.

First, the clinical examination was performed by a professional surgeon. The type of trauma, age and Gender of patients were recorded accurately in a checklist. The elapsed time between the nasal trauma and the time of examination was

accurately calculated. The clinical symptoms including asymmetry of nasal pyramids, edema and ecchymosis, bleeding, nasal congestion, and olfactory sensory changes were also documented. Patients with the history of nose surgery, fractures with scar tissue and nasal skin lacerations, patients' dissatisfaction and pregnant women were excluded from the study due to the difficulty of performing an ultrasound. Lateral nasal bone radiography was taken from the patients routinely (radiography was performed by a radiology technician). Then, patients underwent sonography using the GE device (the LOGIC P6 model) and the linear high frequency (11,000) probe for examination of nasal bone and cartilage was performed by a radiologist. Hypo-echo lines and loss of bone in nose ultrasonography were considered as fractures (suture line from a non-displaced nasal fracture on sonography differed by a specific location for natural suture and present of edema and hematoma). The ultrasound was performed by a radiologist who was unaware of clinical examination. The radiographs were also performed by the same person without knowledge of the patient's profile.

Given that the initial diagnosis of nasal fracture was based on clinical findings, but our golden standard for nasal fracture detection was the result of reduction during the operation. So, positive results of radiographic, sonographic and the clinical examination findings that helped the diagnosis were compared to the findings during surgery. In other words, sensitivity and specificity of each diagnostic method which were used in this study were identified and compared.

### Statistical Analysis

Data were analyzed using SPSS software version 21.0 for Windows (SPSS Inc., Chicago, IL). The means of groups were

compared using parametric or non-parametric tests according to the result of 1-sample K-S test for normal distribution. P-values less than 0.05 were considered statistically significant.

**Results**

In this study, 200 patients including 136 men (68%) and 64 women (32%) participated. The mean age of participants was 23.16 ranging from 4 to 71 years old. Patients with blunt trauma were entered into the study. In this research, the most common blunt trauma was falling down and 77 patients (38.5%) had

mentioned nose trauma following falling to the ground. The other common causes were nose trauma during work or sport (55 patients, 27.5%), hitting hard objects such as a wall or door (37 patients, 18.5%) and accidents (31 patients, 15.5%). Among the studied patients, 65 (32.5%) mentioned the history of nose trauma for which they had done nothing. The signs, symptoms and imaging findings that existed in the patient's biography and on physical examinations, etc. are shown in Table 1.

**Table 1.** Clinical and para-clinical findings of the studied patients

Signs Symptoms	Symptoms							
	Ecchymosis	Nasal Deformity	Tissue Edema	Crepitation	Epistaxis	Pain And tenderness	hyposmia	Nasal Congestion
N* (%)	80 (40)	149 (74.5)	96 (48)	96 (48)	163 (81.5)	189 (94.5)	29 (14.5)	52 (26)
Imaging Findings	Hematoma	Edema	Dorsum fx**	Septal fx	Fx line			
N (%)	68(34)	152(76)	177(88.5)	40(20)	165(82.5)			

\*Number (percent) \*\*Fracture

Among the 200 candidates for nasal fracture reduction surgery, 181 patients (90.5%) had new fractures and during surgery were reduced successfully and 19 patients (9.5%) had

old fractures and the deformities were not modifiable by reduction. The findings of the three diagnostic modalities used in this study are shown in Table 2.

**Table 2.** Results of ultrasound, x-ray graphs and clinical examinations of patients

Fracture and diagnostic modalities	Dorsum and lateral nasal wall		Nasal Septum	
	Yes	NO	Yes	NO
	N (%)	N (%)	N (%)	N (%)
Definitive Nasal Bone Fx In Examination	95 (47)	-	12(6)	188(94)
Possibly Broken Nose in The Examination	105(53)	-	-	-
Nasal Bone Fx In Sono	177(88.5)	23(11.5)	40(20)	160(80)
Nasal Bone Fx In Graphy	165(82)	35(18)	53(26.5)	147(73.5)
Nasal Bone Fx During Surgery	181(90.5)	19(9.5)	12(6)	188(94)

Statistically, there was a significant relationship between the ultrasonography findings and those obtained during

reduction surgery. Table 3 shows the sensitivity and specificity of the study diagnostic tools.

**Table 3.** Sensitivity and specificity of study diagnostic tools in fractures of different parts of the nose

Dignostic Modality	Sensitivity (%)	Specificity (%)
Dursam and lat wall fx in graphy	84	31.6
Septal fx in graphy	75	76.5
Dursam and lat wall fx in Sono	97.8	100
Septal fx in Sono	100	85
Dursam and lat wall fx on examination	52.5	-
Septal fx on examination	100	100

Patients who did not have certain fractures were not entered into the study.

## Discussion

Nasal fracture is very common and its primary diagnosis is mainly based on clinical examinations after the incidence.<sup>3</sup> the accuracy of clinical examination may be decreased due to the edema after the trauma which could make the diagnosis difficult. In this regard, ultrasonography has been introduced as an alternative modality to assess the nasal fracture, as it is inexpensive, fast and has no side effects or radiation exposure.<sup>6, 7</sup> In this study, ultrasonography with 11-MHz probe was used for nasal fracture diagnosis and its specificity and sensitivity were investigated in comparison with the clinical examination and simple radiography rather than the findings during the surgery.

Previous studies have also applied 10-MHz probe for ultrasonography application (9, 10). In our study, the mean age of the patients was 23.16 and nasal fracture in men was twice women. This finding is in line with the studies conducted by Ashoor et al. and Mohammadi et al. (11,12). The most

common symptom was pain and tenderness during clinical examination followed by epistaxis as the second common symptom of trauma which was similar to the study by Tarek Fouad Youssef et al. (13). The rarest symptom was hyposmia; but in the mentioned study, the rarest symptom was nasal depression. The patients' symptoms were not recorded in the other studies. The most common etiology of nasal fracture was falling to the ground followed by nose collision to hard objects which was similar to the findings obtained by Ashoor et al. (11). this study showed that the sensitivity of sonography is higher than clinical examination and simple radiography in the diagnosis of nasal dorsum and lateral wall fracture. The specificity of this method was also higher than the two other mentioned methods. Fouad Youssef *et al.* reported that ultrasonography had a sensitivity of 97% and specificity of 98% (13). Findings of Mohammadi *et al.* also showed the sensitivity of 90% and specificity of 98% for ultrasonography (12).

Clinical examination has specificity and sensitivity of 100% for the diagnosis of nose septum fracture. Ultrasonography estimated nasal fracture more which could be

due to the fact that this method is capable of detecting cracked fractures and those without any displacement which do not need any reduction. But clinical examination can diagnose the fractures which require reduction. Although the sensitivity and specificity of ultrasonography in the diagnosis of nose septum fracture were high (100% and 85%), but in the previous studies, nasal septum fractures were not evaluated by ultrasonography and clinical examination (14-16).

The reason for ultrasonography superiority over radiography could be the dynamic pictures of ultrasonography in a way that the operator can have different pictures of nasal structure in different plans. In the present study, the specificity of radiography was reported low in the diagnosis of nasal fracture. Simple radiography has a high rate of fake positive outcomes (68%) which could be due to the presence of inter-bone sutures and blood vessels and old fractures, as only a few fractures are repaired by ossification (15%). In our study, the radiography sensitivity to nasal fracture was similar to the previous studies. 12, 13 the sensitivity was obtained 84% and 75% for nasal dorsum and lateral wall fractures, respectively. Farshchian et al. (17) mentioned the sensitivity of 81% and specificity of 50%; while Fouad Youssef et al. reported 74% and 87% for the mentioned parameters, respectively (13). In this study, the specificity for nasal dorsum and lateral wall was 31.6% and 76.5% for septum. This specificity was lower than the previous studies which could be due to a higher sample size of this study in comparison with the previous ones. (10, 13). Moreover, in most of the previous studies, the history of nasal trauma was one of the inclusion criteria, while in this study the included patients were those patients who were candidates of surgery due to the high probability of nasal fracture based on their clinical examination (18,19). Previous studies also

introduced clinical examinations as the golden standard test; while our study mentioned surgery findings as the golden standard (20). The site of fracture was not specified in previous studies, whereas this study investigated septum and nose lateral wall fractures separately, which could be one of the strengths of this study. Our study had a few children under the age of ten, but ultrasonography succeeded in the diagnosis of almost all the dorsum and nose lateral fractures which is in line with the results of the study conducted by Hong et al. on the nasal fracture among children, although the results were not statistically significant due to the low sample volume (21).

### Conclusion

According to the obtained results, ultrasonography can be regarded as a simple, applicable, harmless and accurate diagnostic tool in the diagnosis of nasal fracture which can replace the simple radiography, especially among pregnant women and children. As nasal septum fracture diagnosis was higher in ultrasonography, further studies can be conducted to answer this question that whether the patients whose nasal fracture was diagnosed by ultrasonography and did not require reduction based on their clinical examination will have septum deviation or nasal blocking in future or not? It is possible to conduct further evaluations with a higher sample size on children and investigate the accuracy of ultrasonography to determine nasal fracture in this age group as they have more cartilage portion in their nose structure. Finally, ultrasound may be of benefit to detect early traumatic septal hematomas.

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