

**ORIGINAL ARTICLE****To study the diagnosis of nasal bone fractures with Ultrasonography and Conventional Radiography**

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**ABSTRACT:**

**Aim:** To study the diagnosis of nasal bone fractures with Ultrasonography and Conventional Radiography. **Methods:** A cross-sectional study was conducted in the Department of Radiology. The conventional Waters and lateral nasal bone view radiography and high resolution ultrasonography of 110 patients with a clinical or forensic indication for the evaluation of nasal bone fracture were investigated. The negative likelihood ratio (LR<sup>-</sup>), positive likelihood ratio (LR<sup>+</sup>), specificity (Sp) and sensitivity (Se) were used for determining the diagnostic accuracy. The negative predictive value (NPV) and the positive predictive value (PPV) were also determined. **Results:** The Se, Sp, LR<sup>+</sup>, PPV and NPV of ultrasonography were higher than radiography (Table 1). The LR<sup>-</sup> of ultrasonography was lower than radiography. The LR<sup>+</sup> of sonography for the diagnosis of nasal bone fracture was 65.70 [9.30–390.12] which represents a large and conclusive increase in the likelihood of the fracture in the presence of positive findings. Furthermore, LR<sup>-</sup> of sonography was 0.30 [0.12–0.23] which proposed a large to moderate decrease in the likelihood of the fracture, in the presence of negative findings. LR<sup>+</sup> of radiography was 5.82 [2.89–6.29] which showed a small increase of the likelihood of fracture in positive results and the LR<sup>-</sup> of x-ray was 0.42 [0.23–0.44] which proposed a small decrease in the likelihood of the fractures when the findings were negative. **Conclusion:** High-resolution ultrasonography can be used as an accurate technique for evaluating nasal bone fracture. Conventional radiography can be replaced by high-resolution ultrasonography.

**Keywords:** Nasal Bone, Fracture, Ultrasonography, Radiography

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**INTRODUCTION**

The nose is the most prominent facial structure and the nasal pyramid is reportedly the most commonly fractured facial bone.<sup>1</sup> Bone fractures are common injuries among them. Bone fracture is a surgical condition in which there is a break in the continuity of the bone. They occur when a sizable force causes the bone to break. Falls, moving collisions and forceful blows are traumatic causes of bone fractures. Diseases that weaken the bones and overuse can also lead to pathological bone fractures.<sup>2</sup> The nose is the most prominent facial structure and the nasal pyramid is reportedly the most commonly fractured facial bone.<sup>3</sup> The nasal pyramid is a complex structure consisting of the two nasal bones and the two frontal processes of the maxillary bone. A nasal fracture can involve any part of the nasal pyramid but the lateral nasal walls, the nasal dorsum and the nasal septum generally require the most attention when assessing a nasal pyramid fracture.<sup>4</sup>

Although clinical examinations are considered standard procedure in the diagnosis of nasal fractures, haematoma and oedema of adjacent tissues make it difficult to diagnose them. Imaging procedures in midface traumas are also needed for forensic reasons.<sup>5</sup> Although a routine radiographic examination is the main diagnostic tool for traumas to the nose, it is not very accurate and it is difficult to determine which

side is fractured on conventional radiographs.<sup>6,7</sup> CT has been considered as a gold standard and it is the procedure of choice for diagnosing complex facial fractures, especially mid-facial fractures.<sup>8-10</sup> However, CT techniques are expensive, are not readily available and provide a high patient exposure dose. Owing to the proximity of the eyes and the thyroid gland, there is an increased risk for cataract and thyroid carcinoma from X-ray exposure. Furthermore, CT techniques cannot be freely used for pregnant women and coronal CT sections cannot be provided for patients with traumas to cervical vertebrae and for non-co-operative patients.<sup>11,12</sup> These considerations make it necessary to find an alternative and appropriate technique to CT imaging. Ultrasonography is a non-invasive, inexpensive technique that has been shown to reveal fractures of different areas of the face, such as the nasal bone,<sup>2,3,6</sup> orbital floor,<sup>9,13</sup> anterior wall of the frontal sinus<sup>6</sup> and zygomatic fractures.<sup>10,14</sup> Previous studies have evaluated the use of ultrasonography in detecting nasal bone fractures in cases where a fracture had already been diagnosed.<sup>4,5</sup> However, the sensitivity and specificity of ultrasonography has not been tested in the diagnosis of nasal bone fractures. The aim of this study was to evaluate the diagnostic value of ultrasonography in detecting nasal bone fractures compared with CT as the reference method in a single-blind study.

## MATERIAL AND METHODS

A cross-sectional study was conducted in the Department of Radiology, after taking the approval of the protocol review committee and institutional ethics committee. After taking informed consent detailed history was taken from the patient or the relatives if the patient was not in good condition. The technique, risks, benefits, results and associated complications of the procedure were discussed with all patients. The study group consisted of 110 patients with nasal bone fracture who were investigated by an otolaryngologist by physical examination for a medical or legal indication. These patients were then examined by conventional radiography and sonography. Physical examination was considered as the gold standard for the diagnosis of nasal bone fracture. All patients were investigated radiographically by a lateral and a Waters view x-ray at the beginning. The results were evaluated by a radiologist. The reports were then recorded as either "positive" or "negative" according to the existence of nasal bone fracture. Then, patients were examined by sonography. Sonographies were done by using an ESAOTE MYLAB 50 ultrasound machine and a 10 MHz linear probe. All sonographic examinations were performed by a radiologist who was expert in soft tissue and musculoskeletal imaging. The radiologists were informed of the primary diagnosis but they knew nothing about the physical examination and also of each other's diagnostic reports. Patients were examined in the supine position and in right, left and longitudinal views for evaluating the right and left side, the lateral wall and the dorsum

of the nose. The positive criterion for sonographic observation was cortical disruption of the nasal pyramid. Soft tissue edema and subperiosteal hematoma was also examined as a possible predictor to differentiate an acute from a chronic fracture. The negative and positive likelihood ratios (LR- and LR+), specificity (Sp), sensitivity (Se), NPV and PPV with their 95% confidence interval were calculated and used for determining the diagnostic accuracy.

## RESULTS

In this study, 110 patients who had nasal bone fracture in their physical examination were investigated by sonography and radiography.

Of these patients, 30 were women and 80 were men. The mean age of patients was 23.5 years. The majority of the cases 98(89.09%) were in the age group of 20-50 years, of which 36(32.73%) were between 20 -30 years and 29 cases (26.36%) were between 30 -40 years. 11 (10%) patients were < 20 years of age group, while 12 (10.91%) were > 50 years. The youngest patient included in the study was a 13 year old male child and the oldest patient was a male of 62 years of age.

Of the 110 patients, 85 had nasal bone fracture (according to physical examination) and 25 patients were found normal but were investigated due to legal issues.

In this investigation, of the 85 clinically proven nasal bone fracture cases, conventional radiography showed a fracture line in 95 cases.

**Table 1 demographic profile of Patients**

Gender	N=110	%
Male	80	72.73
Female	30	27.27
Age		
Below 20	11	10
20-30	36	32.73
30-40	29	26.36
40-50	22	20
Above 50	12	10.91

**Table 2 Diagnostic Values of Conventional X-ray and Ultrasonography**

Diagnostic Accuracy Values	Ultrasonography [95% CI]	Conventional X-ray [95% CI]
Sensitivity (Se)	0.96 [0.88–0.99]	0.83 [0.73–0.88]
Specificity (Sp)	0.98 [0.91–0.99]	0.88 [0.76–0.99]
Positive Likelihood Ratio (LR <sup>+</sup> )	65.70 [9.30–390.12]	5.82 [2.89–6.29]
Negative Likelihood Ratio (LR <sup>-</sup> )	0.30 [0.12–0.23]	0.42 [0.23–0.44]
Positive Predictive Value (PPV)	0.98[0.93–0.99]	0.92 [0.84–0.97]
Negative Predictive Value (NPV)	0.92 [0.82–0.96]	0.77 [0.63–0.84]

95% CI: 95% Confidence Interval

All 110 patients were examined by ultrasonography. The fracture line was shown in 80 out of 85 cases with a clinically diagnosed nasal bone fracture. Although physical examination results were positive for nasal bone fracture in 8 of the patients, the fracture line

could not be found in ultrasonography (Table 1). The Se, Sp, LR<sup>+</sup>, PPV and NPV of ultrasonography were higher than radiography (Table 1). The LR<sup>-</sup> of ultrasonography was lower than radiography. The LR<sup>+</sup> of sonography for the diagnosis of nasal bone fracture

was 65.70 [9.30–390.12] which represents a large and conclusive increase in the likelihood of the fracture in the presence of positive findings. Furthermore,  $LR^-$  of sonography was 0.30 [0.12–0.23] which proposed a large to moderate decrease in the likelihood of the fracture, in the presence of negative findings.  $LR^+$  of radiography was 5.82 [2.89–6.29] which showed a small increase of the likelihood of fracture in positive results and the  $LR^-$  of x-ray was 0.42 [0.23–0.44] which proposed a small decrease in the likelihood of the fractures when the findings were negative.

## DISCUSSION

Because of the low Sensitivity of radiography, the diagnosis of nasal bone fracture is usually performed by physical examination.<sup>15</sup> The Sensitivity of lateral and Waters radiographic view for the diagnosis of nasal bone fracture has been mentioned 75% in the previous studies.<sup>16</sup> CT scan precisely show anatomic details of the nasal bone and the soft tissue, but it is not always sufficient. The fine nasal fracture line might be missed from the partial volume artifact effect of CT.<sup>15</sup> The previous study showed that sonography can even show a disruption of 0.1 mm in nasal bones.<sup>17</sup> So far only six studies have been conducted to evaluate sonography for the diagnosis of nasal bone fracture. In a study on 63 patients, Oliver et al., found that the accuracy of sonography is more than radiography in diagnosing the fracture line.<sup>15</sup>

In another study carried out by Hyun et al., it was found that the Sensitivity of sonography in diagnosing nasal bone fracture is more than radiography.<sup>15</sup> In a study on 18 patients, Danter reported a Sensitivity of 83% and a Specificity of 50% using a 20-MHz sonography probe compared to physical examination. He also showed that the Se and Sp of sonography compared to radiography is 94% and 83%, respectively.<sup>18</sup> Kown showed a positive correlation between sonography and CT by evaluating 45 patients suspected of having nasal bone fracture.<sup>19</sup> Beck et al., investigated 21 patients suspicious of having nasal bone fracture using a 5–7.5 MHz linear probe and showed that all the fracture lines shown by radiography were also diagnosed by sonography.<sup>17</sup> Zagolski and Streck showed that in individuals with nasal bone fracture the diagnosis can be made exclusively on the results of the sonographic examination.<sup>20</sup> In this study, we used a 10-MHz linear probe and the results of this study were similar to those from Beck et al.,<sup>19</sup> who used a 5–7.5 MHz probe, and also were similar to the studies of Danter who used a 20 MHz probe.<sup>17</sup> In our study, it was shown that while radiography is not able to differentiate chronic from acute fracture lines, sonography can help diagnosing the acuteness of the fracture by showing subperiosteal hematoma and soft tissue edema. Sonography can show trauma of the cartilaginous part of the nose more accurately than radiography.<sup>15</sup> Sonography is a fast, cheap and

accurate method for diagnosing nasal bone fractures and can show anatomic details of the nose much better than conventional radiography. Finally, sonography can be a very fast imaging method in suspected cases of nasal bone fracture and by using this method there would be no need to use radiography.

## CONCLUSION

High-resolution ultrasonography can be used as an accurate technique for evaluating nasal bone fracture. Conventional radiography can be replaced by high-resolution ultrasonography.

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