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Comparison of Ultrasonography and Conventional Radiography in the Diagnosis of Nasal Bone Fractures

Background/Objective: We evaluated the diagnostic accuracy of ultrasonography and conventional radiography compared to clinical examination as the gold-standard technique to determine whether ultrasonography can be the primary diagnostic method for the evaluation of nasal bone fracture.

Patients and Methods: The conventional Waters and lateral nasal bone view radiography and high resolution ultrasonography of 171 patients (128 men, 43 women; mean±SD age, 24±8 years) with a clinical or forensic indication for the evaluation of nasal bone fracture were investigated. The negative likelihood ratio (LR-), positive likelihood ratio (LR+), 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: Of 103 fracture lines in patients with a clinically diagnosed nasal bone fracture, conventional radiography detected 80, while ultrasonography detected 90 fractures. The Se of ultrasonography and conventional radiography was 90.2% and 77.6%, respectively; the Sp was 98.5% and 82%, respectively.

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

Keywords: Nasal Bone, Fracture, Ultrasonography, Radiography

Introduction

Nasal bone fracture is one of the most common fractures among the facial bones in patients with a maxillofacial injury.[1] It involves 39% of maxillofacial bone fractures.[2] This fracture is more common in men than women by a ratio of 2 to 1.[3]

Nasal bone fracture is common between 15–25 years of age but after 60 years, a second peak in incidence is observed.[4] In general, young people are more susceptible to fractures and displacement but in the elderly, comminuted fractures are more common.[5]

Almost 80% of nasal bone fractures occur between the middle third and the inferior part of the nose.[6] Many studies have shown that radiography cannot be used accurately for the routine evaluation of nasal bone fractures.[7] Studies show that radiographic investigations were negative in 25% of patients with nasal bone fracture who needed surgical operation.[7]

In one evaluation, to determine the efficacy of Waters view in 55 nasal bone fractures that did not have a previous history of nasal trauma, this radiographic method caused false positive results in 33% of cases.[8] Therefore, if nasal trauma has no legal aspects and does not cause any cosmetic or breathing problems, there is no need to use a routine radiography.[9]

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We know that physical examination is the only gold standard method for the diagnosis of nasal bone fracture.[10]

According to the high positive (PPV) and negative predictive values (NPV) of lateral and Waters radiography for the diagnosis of nasal bone fractures,[7,8] and considering the high dose of X ray imposition to the region, this study was conducted to evaluate the efficacy of high resolution ultrasonography—a cheap, available, simple, possible and without ionizing radiation method—in the diagnosis of nasal bone fracture, especially for forensic problems.

Patients and Methods

This cross-sectional study was carried out from February 2007 to February 2008 in the Radiology Department of Imam Khomeini Hospital of Urmia.

Informed written consent was obtained from all the patients.

The study group consisted of 171 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 who had enough experience on interpreting nasal radiographs. 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 another radiologist who was blinded to the results of radiography or physical examination, 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 (Figs. 1 and 2).

The positive criterion for sonographic observation was cortical disruption of the nasal pyramide (Fig. 3).

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, 171 patients who had nasal bone fracture in their physical examination were investigated by sonography and radiography.

Of these patients, 43 were women and 128 were men. The mean age of patients was 24 (range: 14–61) years. Of the 171 patients, 103 had nasal bone fracture (according to physical examination) and 68 patients were found normal but were investigated due to legal issues.

In this investigation, of the 103 clinically proven nasal bone fracture cases, conventional radiography showed a fracture line in 80 cases.

Table 1. Diagnostic Values of Conventional X-ray and Ultrasonograghy

Diagnostic Accuracy Values	Ultrasonograghy [95% CI]	Conventional X-ray [95% CI]
Sensitivity (Se)	0.90 [0.82–0.95]	0.77 [0.68–0.85]
Specificity (Sp)	0.98 [0.91–0.99]	0.82 [0.71–0.99]
Positive Likelihood Ratio (LR^+)	61.40 [8.77–430.05]	4.40 [2.61–7.43]
Negative Likelihood Ratio (LR^-)	0.10 [0.05–0.18]	0.27 [0.19–0.39]
Positive Predictive Value (PPV)	0.98 [0.93–0.99]	0.87 [0.78–0.93]
Negative Predictive Value (NPV)	0.87 [0.77–0.93]	0.71 [0.59–0.80]

95% CI: 95% Confidence Interval

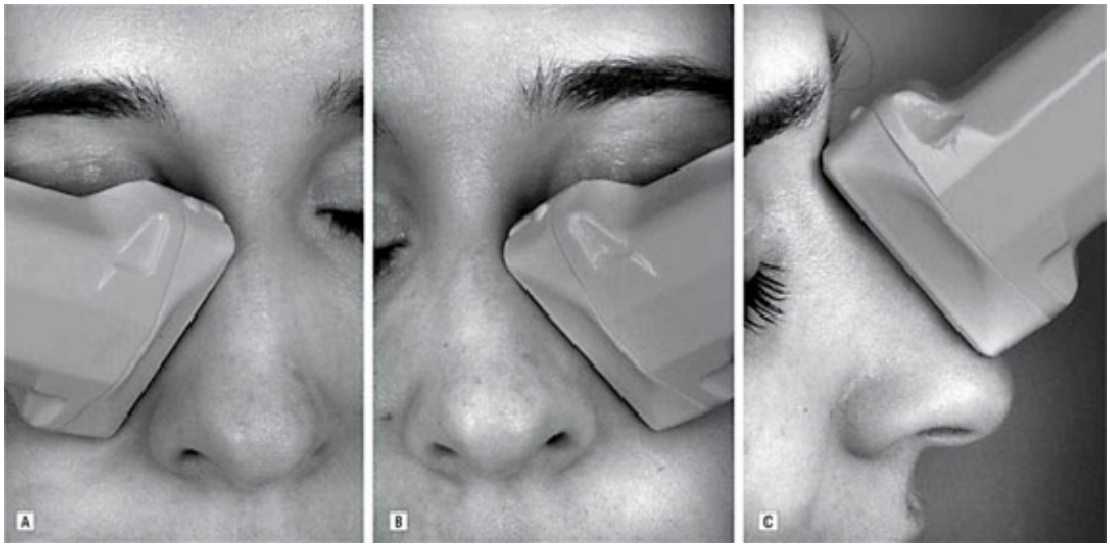

Fig. 1. The positions of applying the ultrasound probe.[11] Courtesy from Oliver Thiede. A) Right lateral wall; B) Left lateral wall; And C) Nasal dorsum.

All 171 patients were examined by ultrasonography. The fracture line was shown in 93 out of 103 cases with a clinically diagnosed nasal bone fracture. Although physical examination results were positive for nasal bone fracture in 10 of the patients, the fracture line could not be found in ultrasonography (Table 1).

The Se, Sp, LR^+, PPV and NPV of ultrasonography were higher than radiography (Table 1). The LR^- of ultrasonography was lower than radiography.

The LR^+ of sonography for the diagnosis of nasal bone fracture was 61.40 [95% CI: 8.77–430.05] which represents a large and conclusive increase in the likelihood of the fracture in the presence of positive findings. Furthermore, LR^- of sonography was 0.10 [95% CI: 0.05–0.18] which proposed a large to moderate decrease in the likelihood of the fracture, in the presence of negative findings. LR^+ of radiography was 4.40 [95% CI: 2.61–7.43] which showed a small increase of the likelihood of fracture in positive results and the LR^- of x-ray was 0.27 [95% CI: 0.19–0.39] which proposed a small decrease in the likelihood of the fractures when the findings were negative.

Discussion

Because of the low Se of radiography, the diagnosis of nasal bone fracture is usually performed by physical examination.[10] The Se of lateral and Waters radiographic view for the diagnosis of nasal bone fracture has been mentioned 75% in the previous studies.[7]

CT can 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.[10]

The previous study showed that sonography can even show a disruption of 0.1 mm in nasal bones.[12] 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.[10]

In another study carried out by Hyun et al., it was found that the Se of sonography in diagnosing nasal bone fracture is more than radiography.[10] In a study on 18 patients, Danter reported a Se of 83% and a Sp 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.[13]

Kown showed a positive correlation between sonography and CT by evaluating 45 patients suspected of having nasal bone fracture.[14]

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.[12]

Zagolski and Strek showed that in individuals with nasal bone fracture the diagnosis can be made exclusively on the results of the sonographic examination.[15]

In this study, we used a 10-MHz linear probe and the results of this study were similar to those from Beck et al.,[14] who used a 5–7.5 MHz probe, and also were similar to the studies of Danter who used a 20

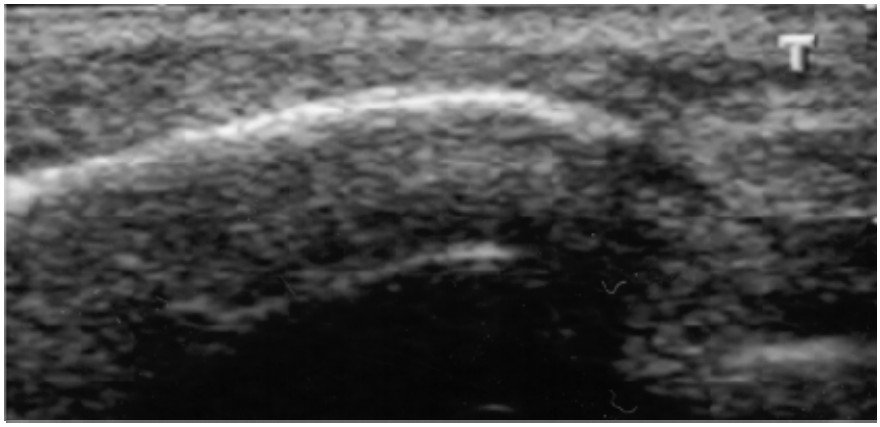

Fig. 2. Normal sonographic finding of the lateral nasal wall in a 27-year-old man after nasal trauma

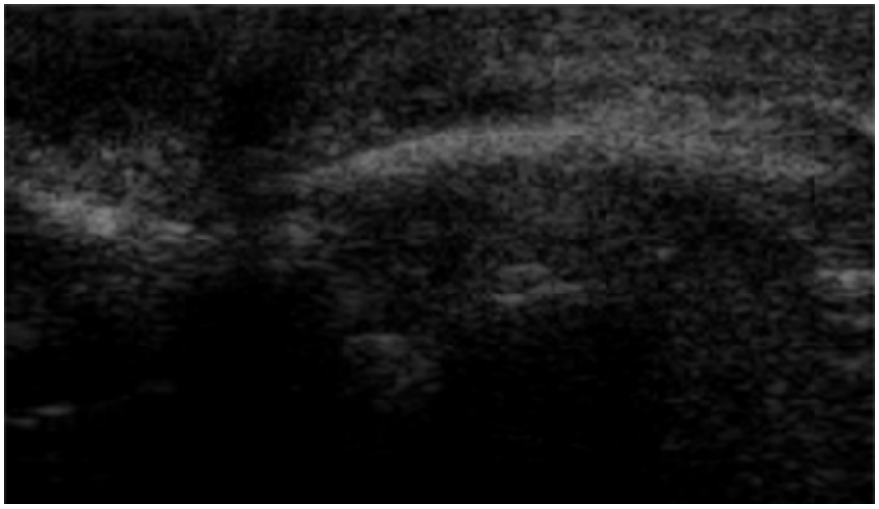

Fig. 3. A 29-year-old man with nose swelling after nasal trauma. Longitudinal sonogram shows a depressed fracture line.

MHz probe.[12]

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.[10]

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.

By using sonography instead of conventional radiography, we can prevent radiation to the optic lens and other complications.

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