Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

Original Research Article

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

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Received: 23-07-2021 / Revised: 11-08-2021 / Accepted: 21-09-2021

Abstract

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

Methods: A cross-sectional study was conducted in the Department of Radiology, VIMS Pawapuri, Nalanda, Bihar, India for 2 years.The conventional Waters and lateral nasal bone view radiography and high resolution ultrasonography of 200 patients (150 men, 50 women; mean age, 22 years (range: 12–58 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 160 fracture lines in patients with a clinically diagnosed nasal bone fracture, conventional radiography detected 140, while ultrasonography detected 152 fractures. The Se of ultrasonography and conventional radiography was 94% and 81%, respectively; the Sp was 99% and 86%, 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 ultrasonography.

Keywords: Nasal Bone, Fracture, Ultrasonography, Radiography

Introduction

The nose is the most prominent facial structure and the nasal pyramid is reportedly the most commonly fractured facial bone.[1] 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

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

are traumatic causes of bone fractures. Diseases that weaken the bones and overuse can also lead to pathological bone fractures.[2] The nose is the most prominent facial structure and the nasal pyramid is reportedly the most commonly fractured facial bone.[3] 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.[4]

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.[5] 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.[6,7] CT has been considered as a gold standard and it is the procedure of choice for diagnosing complex facial fractures, especially mid-facial fractures.[8-10] 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.[11,12] 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,[2,3,6] orbital floor,[9,13] anterior wall of the frontal sinus[6] and zygomatic fractures.[10,14] Previous studies have evaluated the use of ultrasonography in detecting nasal bone fractures in cases where a fracture had already been diagnosed.[4,5] 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 VIMS PAWAPURI, Nalanda, Bihar, India, for 2 years . after taking the approval of the protocol review committee and institutional ethics committee.The study group consisted of 200 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 pyramide . Soft tissue edema and subperiosteal hematoma was also examined as a possible predictor to differentiate an acute from a chronic

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

Of these patients, 50 were women and 175 were men. The mean age of patients was 22 (range: 12–58) years. The majority of the cases 184(92%) were in the age group of 20-58 years, of which 80 (40%) were between 20 and 30 years and 60 cases (30%) were between 30 -40 years. 12 (6%) patients were < 20 years of age group, while 16 (8%) were > 50 years. The youngest patient included in the study was a 12 year old male child and the oldest patient was a male of 58 years of age.

Of the 200 patients, 160 had nasal bone fracture (according to physical examination) and 40 patients were found normal but were investigated due to legal issues.

In this investigation, of the 160 clinically proven nasal bone fracture cases, conventional radiography showed a fracture line in 140 cases

Table 1: demographic profile of Patients

Gender	**N=200**	**%**
Male	150	75
Female	50	25
Age		
Below 20	12	6
20-30	80	40
30-40	60	30
40-50	32	16
Above 50	16	8

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

Diagnostic Accuracy Values	**Ultrasonograghy [96% CI]**	**Conventional X-ray [96% CI]**
Sensitivity (Se)	0.94 [0.86–0.97]	0.81 [0.71–0.86]
Specificity (Sp)	0.99 [0.89–0.98]	0.86 [0.74–0.97]
Positive Likelihood Ratio (LR+)	64.80 [9.28–390.10]	5.80 [2.87–6.27]
Negative Likelihood Ratio (LR^-)	0.20 [0.10–0.21]	0.40 [0.21–0.42]
Positive Predictive Value (PPV)	0.99[0.91–0.97]	0.90 [0.82–0.95]
Negative Predictive Value (NPV)	0.91 [0.81–0.94]	0.75 [0.61–0.82]

96% CI: 96% Confidence Interval

All 200 patients were examined by ultrasonography. The fracture line was shown in 152 out of 160 cases with a clinically diagnosed nasal bone fracture. Although physical examination results were positive for nasal bone fracture in 12 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 64.80 [96% CI: 9.28–

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390.10 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 [96% CI: 0.10–0.21] which proposed a large to moderate decrease in the likelihood of the fracture, in the presence of negative findings. LR+ of radiography was 5.80 [96% CI: 2.87–6.27] which showed a small in- crease of the likelihood of fracture in positive results and the LR^{-} of x-ray was 0.40 [96% CI: 0.21–0.42] 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.[15] The Sensitivity of lateral and Waters radiographic view for the diagnosis of nasal bone fracture has been mentioned 75% in the previous studies.[16] 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.[15] The previous study showed that sonography can even show a disruption of 0.1 mm in nasal bones.[17] 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.[15]

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.[15] 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[18].Kown showed a positive correlation between sonography and CT by evaluating 45 patients suspected of having nasal bone fracture.[19] 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.[17] Zagolski and Strek showed that in individuals with nasal bone fracture the diagnosis can be made exclusively on the results of the sonographic examination.[20] In this study, we used a 10-MHz linear probe and the results of this study were similar to those from Beck et al.,[19] who used a 5–7.5 MHz probe, and also were similar to the studies of Danter who used a 20 MHz probe.[17] 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.[15] 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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