The Role of Ultrasound In The Management Of Fractured Nose

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Abstract

Background: the nose is the most prominent part of the face so it is more liable to be injured in an  
accidental or assault types of facial trauma. Radiological assessment plays a role in the management of  
fractured nose. Objectives: 1. To compare the ultrasound image with plain X-ray in the diagnosis of nasal  
fractures. 2. To compare the findings of ultrasonography at the time of presentation and after the oedema  
subsided in patients with nasal injuries. Patients and Methods: this study was conducted at Al-Hussein  
Teaching Hospital/ Samawah city /Iraq during the period from January 2016 to December 2016. All  
patients with nasal trauma were included in this study. All patients were clinically examined by  
otolaryngologist. Conventional radiography and ultrasonography of the nose were performed for all  
patients and compared with the clinical diagnosis. Results: The sensitivity and specificity of  
ultrasonography and plain radiography in comparison with clinical diagnosis of nasal bone fracture was  
97.8% and 85.7%, 88.6% and 62.5% respectively. Three cases were missed as nasal bone fractures on  
clinical examination at the time of the presentation while the results of ultrasonography remained similar  
whether it was taken during the time of the presentation or following the resolution of the nasal oedema.  
Conclusion: ultrasonography is more reliable than conventional radiography in the assessment of acute  
nasal injuries. Ultrasonography is not affected by the nasal oedema in the assessment of nasal bone  
fractures.

Keywords: fracture, nasal bone, ultrasonography

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Introduction

Nasal bone fracture is the most common facial fracture that has be seen in trauma setting. There is no  
consensus among otolaryngologists about the standard classification of nasal bone fractures, but there are  
attempts by researchers to classify them1,3. A fracture of the nasal bone is usually easily diagnosed by  
clinical examination and plain X-ray of the nose in 2 views (lateral and occipitomental); however, there are  
limitations to conventional radiography in the assessment of nasal bone fractures1,4,5. Computed  
tomography (CT) in axial and coronal views is better than conventional radiography for assessment of nasal
bone fractures and associated facial injuries\textsuperscript{2,5,6}. Some authors found that conventional radiography is inappropriate in the assessment of the nasal bone fracture\textsuperscript{4}, however, adequate imaging of the fractured nasal bone is often necessary for legal purposes. Ultrasonography is an alternative to conventional radiography, as it is a common, quick and non-invasive method with no additional radiation exposure. Klinger et al\textsuperscript{7} reported that B-mode ultrasonography is a valuable and low cost tool to identify fractures of the orbital floor. Several previous studies\textsuperscript{1,8-12} have dealt with the diagnosis of nasal bone fractures by ultrasound imaging. Although Computed tomography (CT) scan is considered a gold standard for diagnosing nasal bone fractures in addition it has ability to differentiate the new from old fractures, however, it has many drawbacks: high cost, high radiation dose, not available everywhere and lack ability in determining which fracture needs reduction as this depends solely on clinical judgment\textsuperscript{13-15} and the nasal fracture alone is not an indication to perform CT scan study in case of facial trauma as it is not done to all cases in this study, moreover, the main advantage of radiological investigation is for legal purposes, so in the present study we used the clinical diagnosis as a standard method for diagnosing nasal fractures. The aims of this study were to compare the ultrasonography and conventional radiography in the evaluation of nasal bone fracture and to compare the results of ultrasound at the time of presentation and after the oedema subsided in patients with nasal injuries.

**Patients and methods**

This prospective study was carried out between January 2016 and December 2016 in otolaryngological and radiological departments of Al-Hussein Teaching Hospital in Samawah city/Iraq. The study was approved by the Surgical Department, College of Medicine, University of Anbar, Ramadi city, Iraq. Sixty patients (22 female and 38 male) with history of nasal injuries and a possible nasal bone fractures were enrolled in this study. Exclusion criteria of the present study included any patient with one or more of the following:

1. Severe external nasal abrasions or deep wounds because these prevent the correct use of ultrasound probe.  
2. Previous nasal trauma  
3. Pregnant women

A thorough history was taken and a proper physical examination was done for every patient. Clinical diagnosis of nasal bone fractures made if there is one or more of the following signs: 1. External nasal deformity (not due to previous trauma) 2. Depressed point on palpation 3. Tenderness over nasal bone 4. Crepitus 4. Mobility of the nasal bone segment/s.

Then 2 views of conventional radiographs (lateral and occipitomental views of the nasal bones) were taken in every injured subject. According to the guidelines of the German Society of Otorhinolaryngology, Head and Neck Surgery, the radiologic assessment of patients was carried out. Furthermore, all participants underwent an ultrasound examination in appropriate positions (Figure 1) by an expert radiologist using a 5-13 MHz ultrasound linear probe (VF 5-13) of a commonly used ultrasound device (Acuson Antaris, Siemens Medical Corp, Italy). The ultrasound probe was applied parallel and perpendicular to the nasal bone without a stand-off pad\textsuperscript{15}. A second assessment by ultrasonography was done once the external nasal oedema subsided. According to the results of clinical examination, conventional radiography, and ultrasonography, a final decision of whether nasal bone was fractured or not, and appropriate treatment was then discussed with the patient.

The data collected from ultrasound and radiographic results were compared with the final clinical diagnosis for sensitivity, specificity and predictive values. Sensitivity was measured using the following equation: \(TP/TP+FN\) (TP, true-positive results; FN, false-negative results); specificity was calculated by the following formula \(TN/TN+FP\) (TN, true negative results; FP, false-positive results); and positive predictive values (PPV) and negative predictive (NPV) values were calculated using \(TP/TP+FP\) and \(TN/FN+TN\),
respectively. The x2 test was applied to the data to assess statistical significance. The SPSS 22 computer software program (SPSS Inc., Chicago, IL) was used for statistical analysis.

**Results**

Sixty patients (38 male and 22 female; age ranged 4-25 year; mean age: 14.2 years ± 7.96) were examined in this study. The final clinical diagnosis of the injured patients showed 48 (80%) patient with fracture of the nasal bone and 12 (20%) without evidence of nasal bone fracture (no clinical signs of the inclusion criteria) Table 1. Out of 48 patient with clinical diagnosis of fracture nasal bone, 39 (65%) were diagnosed by conventional radiography and 45 (75%) were diagnosed as having nasal bone fractures by ultrasonography. There is no statistical significant P value > 0.05 when comparing the results of radiography and ultrasonography. There is also no statistical significant difference when comparing each modality of radiological images (conventional radiography and ultrasonography) with the clinical diagnosis of nasal bone fractures P value > 0.05. Ultrasound findings of 12 (20%) patients showed no fracture and 10 (16.6%) subjects were not identified to have fracture with the conventional radiography Table 1. There is no statistical significant difference between them. The number of patients with fractures on clinical examination following the resolution of oedema changed from 45(75%) to 48 (80%), 3 (5%) of them with nondisplaced fractures and required no treatment, and without fractures 12 (20%) while the results of ultrasonography remained the same at the time of presentation and following oedema resolution. All the preceding results showed no statistical significant P value > 0.05 Table 2. The sensitivity and specificity of ultrasonography in detection of nasal bone fractures in comparison with clinical diagnosis were 97.8% and 85.7%, respectively while the sensitivity and specificity of radiography in identification of nasal bone fractures in comparison with conventional radiography were 88.6% and 62.5%, respectively. The PPV and the NPV of ultrasonographic assessment of the nasal bone fractures were 95.7% and 66.7% respectively while the PPV and the NPV of conventional radiography evaluation of the nasal fractures were 86.6% and 66.7% % respectively. Figure 2 shows the 24 year female with acute accidental trauma to the nose (a) the plain radiograph of the patient – lateral view(b) and ultrasonography of the patient (c). Both films showed the fracture in the patient.

![Figure 1](https://example.com/figure1.png)

Figure 1: (a), (b) and (c) the position of patient and the probe during ultrasound examination, the ultrasound probe is parallel and perpendicular over dorsum and lateral nasal wall.

![Table 1](https://example.com/table1.png)

Table 1: Comparison of final clinical diagnosis of nasal bone fracture with the results of ultrasonography and conventional radiography (x2 test= 0.06, P value=0.8)

<table>
<thead>
<tr>
<th>Final clinical diagnosis</th>
<th>Total No.</th>
<th>%</th>
<th>Conventional radiography No.</th>
<th>%</th>
<th>Ultrasonography No.</th>
<th>%</th>
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<tr>
<td>Clinical diagnosis</td>
<td>At the time of the presentation</td>
<td>After oedema subsided</td>
<td>At the time of the presentation</td>
<td>After oedema subsided</td>
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<td></td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
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<tr>
<td>Nasal bone fractures</td>
<td>45 (75%)</td>
<td>48 (80%)</td>
<td>45 (75%)</td>
<td>45 (75%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No nasal bone fractures</td>
<td>12 (20%)</td>
<td>12 (20%)</td>
<td>12 (20%)</td>
<td>12 (20%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>False negative</td>
<td>3 (5%)</td>
<td>1 (1.7%)</td>
<td>1 (1.7%)</td>
<td>1 (1.7%)</td>
<td></td>
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<tr>
<td>False positive</td>
<td>2 (3.3%)</td>
<td>2 (3.3%)</td>
<td>2 (3.3%)</td>
<td>2 (3.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>60 (100%)</td>
<td>60 (100%)</td>
<td>60 (100%)</td>
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Table 2: Comparison of ultrasonography findings at the time of the presentation and at the time following oedema subsided.

Discussion

Nasal fracture is usually diagnosed by taking good history, performing physical examination and by assessing radiologic findings. A physical examination is important because of the low sensitivity of radiography\(^{16-17}\). The sensitivity of the occipitomental view and the sensitivity for identifying fracture of the nasal bones on both the radiograph lateral views are reported to be 53–63\(^\%\)\(^{18}\). The false-positive findings are reported to be the midline nasal suture, the nasomaxillary suture, and developmental defects or thinning of the nasal wall; and the false-negative findings are the short radiolucent lines reaching the anterior aspect of the nasal bone\(^{16}\). It is essential to reassess the patients with nasal injury after the nasal oedema resolved because edema can mask a mild to moderate nasal bone fractures and may hinder the surgeon if performing a closed reduction immediately\(^{15}\). However radiological assessment (plain X-ray, CT scan and ultrasonography) is vital not only for the diagnosis of the fracture but also for medicolegal purposes. Although conventional radiography is not identify the line of nasal bone fractures well\(^{15}\), it is available in all hospitals, low cost and less radiation exposure than CT. Around 30 years ago, ultrasonography has been used by researchers as an alternative technique in the assessment of maxillofacial fractures because it is...
easy, quick to perform, low cost, available, portable, free of radiation and non-invasive.\textsuperscript{11,15} Ultrasound has been considered to be a reliable tool for the diagnosis of facial bone fractures.\textsuperscript{19} Ultrasound is a rapid and easy to perform, portable, noninvasive and free of radiation exposure and it can replace plain X-Ray.\textsuperscript{20} Moreover, it is more accurate than CT (computed tomography) scan in nasal bone fractures as mentioned in previous studies.\textsuperscript{21,22} In the previous study by Danter et al,\textsuperscript{9} evaluation of the nasal bone fracture achieved a sensitivity of 83\% if the clinical diagnosis was used as the reference and a sensitivity of 94\% if the radiography results was considered. While the present study showed a 97.8\% sensitivity of ultrasonography in the detection of nasal bone fracture if the clinical diagnosis was used as a reference. Despite the usefulness of ultrasound in the diagnosis of bone fractures, it carries a major two disadvantages: it depends on personal experience and training and interoperator variability.\textsuperscript{23} In Thiede et al\textsuperscript{1} study, analysis of the findings has been performed by two readers which showed no significant difference. The limitation of this study was that only one reader analyzed the findings of ultrasonography. The study was not take in consideration the site and the number of nasal bone fractures in each patient and these are considered other limitations of the present study. Danter et al\textsuperscript{13} study demonstrated that there is no difference in identification of nasal bone fractures in 8 patients by using 20-MHz or 7.5-MHz ultrasound probe, despite the better surface resolution of the uncommon 20-MHz ultrasound probe, in addition to this cause, the 10-MHz ultrasound probe is the most commonly ultrasound instrument used in the evaluation of the head and neck pathology in routine daily practice, the 10-MHz probe was used in this study. Ultrasound technique has no radiation so it can be used many times in order to achieve proper images for correct diagnosis. Tamada et al\textsuperscript{24} used Fuchu-Kids algorithm for the treatment of children with possible nasal bone fracture. The ability of the Fuchu-Kids algorithm had a similar specificity but higher sensitivity, positive predictive value and negative predictive value than single ultrasound examination in the assessment with nasal bone fracture. They also concluded that ultrasonography must be repeated even when the first ultrasound exam didn’t show nasal fracture if there is persistence of clinical symptoms of nasal fracture. Although the present study showed no statistical significance regarding the results of ultrasonography at the time of presentation of patient with acute nasal trauma and the findings of ultrasound images when taken following edema subsidence in the identification of nasal fracture, it is a good practice to repeat the ultrasonography once the oedema has resolved. The presence of subperiosteal hematoma and soft tissue edema on ultrasonographic evaluation of patients with proven nasal bone fractures clinically used by researchers as signs for acute nasal fracture. These signs cannot be seen on radiography, so ultrasound images can differentiate acute from chronic fractures according to the presence or absence of these 2 signs. Ultrasound examination has other benefits over the usage of plain X-ray is that, it can identify nasal cartilages more accurately and also its usefulness in reduction of nasal bone intraoperatively.\textsuperscript{22} The present study excluded any patient with previous nasal trauma, so the comparison between recent and old nasal fractures is out of the scope of this study.

The previous study by Thiede et al\textsuperscript{1} compared ultrasonography and conventional radiography in the diagnosis of nasal bone fractures in 63 patients with possible fractures of nasal bone. The results of ultrasound in comparison with the conventional radiography method in the assessment of the lateral nasal wall showed a statistically significant (P= 0.04). While, the conventional radiography method carried higher accuracy rates compared with ultrasound images in the assessment of the nasal dorsum, which was statistically significant. Despite that all the ultrasound images were assessed by two examiner, which might have resulted in inter-examiner differences, the findings did not show a significant difference between the two examiners, however, the authors emphasized that findings of an ultrasonography are better when the technique is performed by the same person reading the findings. Friedrich et al\textsuperscript{17} carried out a study on 81 patients...
patients with relevant signs of mid-facial fractures. The study showed that the most important disadvantage of the ultrasonography was related to the identification of non-displaced fractures of facial bones. The other disadvantage was ultrasonography does not correctly identify the peripheral fracture lines extension toward the central depressions. The findings indicated that the signal of ultrasound has a relative function in the nasal cartilage; therefore, there is interference between bone and cartilage by ultrasound. All the displaced fractures were identified by the ultrasonography. In our study, ultrasonography missed 3 non-displaced nasal bone fractures in comparison with final clinical diagnosis of nasal fractures.

In conclusion ultrasonography is cheap, quick and easy to perform, portable, non-invasive, free of radiation and valuable in the assessment of nasal bone fractures. Our study yielded a 97.8% sensitivity of ultrasound images in diagnosing nasal fractures if clinical judgment was used as a reference, so it can be used as primary radiological tool for the evaluation of subjects with nasal trauma. Although there is no difference in the results of ultrasound images at the time of the presentation and after resolution of the oedema, it is a good practice to repeat the ultrasound examination following oedema subsidence.

References:


