

DETERMINATION OF CUT-OFF POINT FOR ULTRASONOGRAPHIC FINDINGS IN NASAL BONE FRACTURE: COMPARISON OF THEIR CONSISTENCY WITH PHYSICAL EXAMINATION AND CONVENTIONAL RADIOGRAPHIC FINDINGS

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ABSTRACT

The aim of this study was to demonstrate the cut-off point of ultrasonographic findings in nasal bone fracture and determining their consistency. A longitudinal, descriptive-analytic study was done on 90 patients (more than 15 years old) with clinical manifestations of a fractured nasal bone. Seventy two patients concluded the study successfully. High resolution ultrasonographic investigations were done by an expert consultant without knowledge of the clinical data or examination in five sessions. After collecting and completing information about patients, the data was analyzed using SPSS software. Ninety consecutive patients were enrolled in the study; Seventy two patients (44 men and 28 women) with the mean age of 26.56±12.3 years concluded the study successfully. In comparing the suggestive criteria for nasal bone fracture in physical examination, nasal bone depression had the most sensitivity (61.29%), epistaxis had the highest specificity (80%) and echymosis had the highest score of positive likelihood ratio (1.37) and the most PPV (89.47%). During the first three weeks after nasal trauma, subperiosteal hematoma and lucency in the lateral nasal bone had the highest diagnostic value which were statistically meaningful (PV<0.001). The predictive value of lateral nasal bone lucency and subperiosteal hematoma for estimating the elapsed time from the onset of nasal trauma in sonographic investigation were 67.7% and 86.3% (95% CI) respectively which were statistically meaningful (P=0.003, P=0.0001). HRUS is a reliable diagnostic tool for determining the chronicity of nasal bone fracture.

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INTRODUCTION

Nasal fracture is the most common mid-facial fracture [1]. The nasal pyramid is a complex structure composed of the paired nasal bones and the frontal processes of the maxillary bone. A thorough attention must be paid to the caudal and cranial part of the nasal bones, as well as the nasal septum when evaluating a nasal trauma. Nasal bone fracture is responsible for about 40% of maxillofacial bone fractures and is twice more common in male than in female [2]. High Resolution Ultra-Sonography (HRUS) is superior to Conventional Radiography (CR) in comparison and that is because of its low cost, availability and lack of radiation risk to the lenses [3]. For comparing the diagnostic value of HRUS with other radiographic investigations such as plain radiography in diagnosing nasal fractures, several studies have been done [4, 5]. Although the gold standard for the diagnosis of nasal fracture is physical examination but occasionally swelling of the surrounding tissues hinder the physician in fracture diagnosis [5, 6]. Most of nasal fractures are located between the middle and inferior third of the nose [7]. Many studies have shown that plain radiography has some short comings in detecting these fracture lines [8]. In some studies plain radiographic investigations were falsely negative in 25% of patients with nasal bone fractures [9]. The purpose of this study was to determine the cut-off point of ultrasonographic findings in nasal bone fractures and comparing their consistency with physical examination and conventional radiologic findings.

MATERIALS AND METHODS

This longitudinal-analytic study, was carried out in Shohada-Ashayer hospital of Lorestan province (southwest of Iran), between April 2012 and April 2014. Sampling method was census. Seventy two patients (44 males and 28 females) concluded the study successfully. All patients with nasal bone manipulation such as closed or open reduction before referral to our hospital and also those with more than five days interval between the trauma and radiologic investigations were excluded from the study.

First of all a thorough rhinologic physical examination was done on all patients by an expert attending of otolaryngology head and neck surgery department in Shohada-Ashayer hospital; Following clinical examination, CR was taken for all the patients. Stepping or lucency in the lateral nasal bone was considered positive for fracture in CR [Figure-1].



Fig: 1. Lucency and stepping in the lateral nasal view.

After performing CR and HRUS, We collected clinical and imaging data of the patients from their clinical data sheets. Clinical examination was considered as the gold standard for the diagnosis of nasal bone fracture, the patients underwent any curative procedures as needed (such as closed or open reduction). All patients were followed for six months regularly (in the first five days, 3rd, 6th, 12th and 24th weeks after trauma). In each session, ultrasonographic examination was done by an expert radiologist who was blinded to the results of CR or physical examinations. A 14 MHz linear probe was used for sonographic evaluation. Patients were examined in the supine position and in right, left and longitudinal views. The transducer was applied directly to the skin without a standoff pad. A single radiologist performed all the ultrasonograms of the nasal bone during the six months study. Cortical disruption of the nasal bone and having lucency or stepping in nasal bones or nasal septum in HRUS was considered as positive finding for fracture [Figures 2-4].

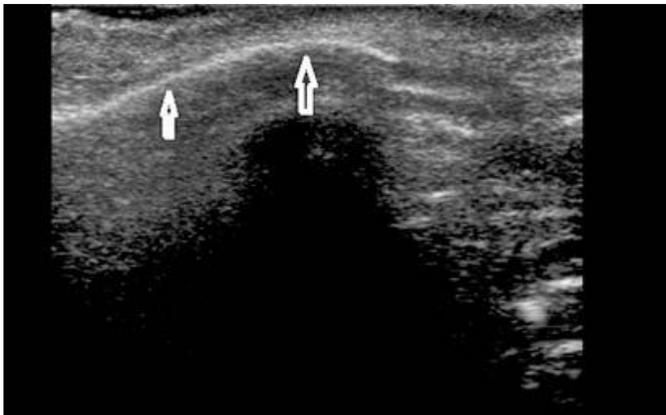


Fig: 2. Oblique longitudinal ultrasonogram shows the normal appearance of the lateral wall of nasal bone as an echogenic line (arrows).

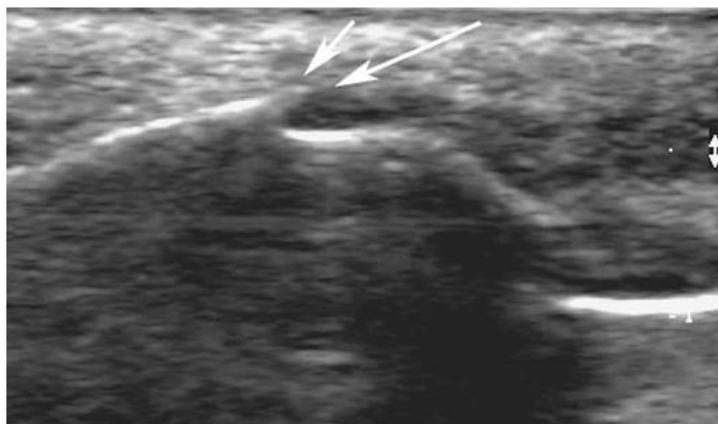


Fig: 3. Sonogram in a patient with a fractured nasal bone (arrows).

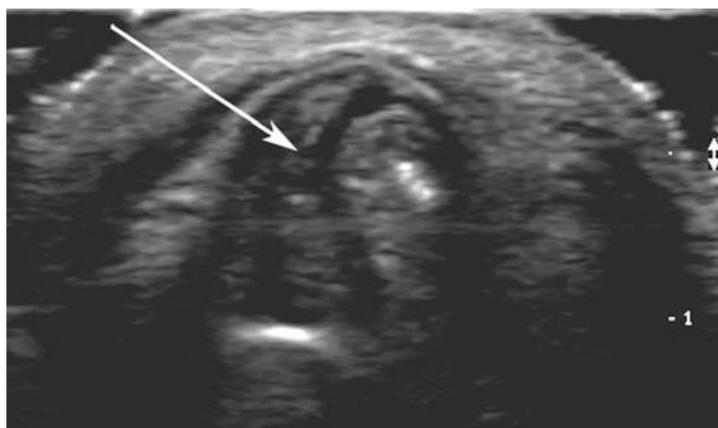


Fig: 4. Sonogram shows lucency in the nasal septum (arrow).

Soft tissue swelling and sub-periosteal hematoma were also examined as possible indicators to differentiate an acute from a chronic fracture line. The thickness of periosteal reactions were measured in each sonographic examination and were compared with the thickness of nasal bone periosteum on the opposite side.

After collecting and completing information about patients, the data was analyzed through descriptive statistical techniques (standard mean scores, ratios, frequency percent and Fishers exact test). Moreover, sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), negative likelihood ratio (LR-), positive likelihood ratio (LR+), and their 95% confidence intervals (CI) were calculated and used for determining the diagnostic accuracy of HRUS in nasal bone fracture.

RESULTS

Ninety consecutive patients were enrolled in the study; Seventy two patients (44 men and 28 women) with the mean age of 26.56 ± 12.3 years (range from 17 to 38 years old) concluded the study successfully. After evaluating the diagnostic value of physical examination findings, mobility had the most sensitivity (80.65%) and the highest score of specificity (100%).

In comparing the suggestive criteria for nasal bone fracture in physical examination, nasal bone depression had the most sensitivity (61.29%), epistaxis had the highest specificity (80%) and echymosis had the highest score of LR+ (1.37) and the most PPV (89.47%). The lucency in the lateral nasal bone during sonographic examination in

the first five days had the highest sensitivity (90.32%) which declined to 64.52% in the 5th session of sonographic investigation. The PPV for lucency of lateral nasal bone in ultrasonographic examination was in the range of 84.85% to 88%. In the first sonographic investigation, the sensitivity of stepping of lateral nasal bone was 77.42%. Sub-periosteal hematoma in the first sonographic evaluation had the most sensitivity (100%). On the other hand the specificity and PPV of sub-periosteal hematoma as a diagnostic tool in nasal bone fracture were in the range of 80% to 100%.

During the first three weeks after nasal trauma, sub-periosteal hematoma and lucency in the lateral nasal bone had the highest diagnostic value which were statistically meaningful ($P < 0.001$). The predictive value of lateral nasal bone lucency and sub-periosteal hematoma for estimating the elapsed time from the onset of nasal trauma in sonographic investigation were 67.7% and 86.3% (95% CI) respectively which were statistically meaningful ($P = 0.003$, $P = 0.0001$).

Among sonographic findings, sub-periosteal hematoma and lucency in the lateral nasal bone were consistent for 25 and 85 days respectively (sensitivity: 90.8% & 66.7% respectively) [Figures 5, 6].

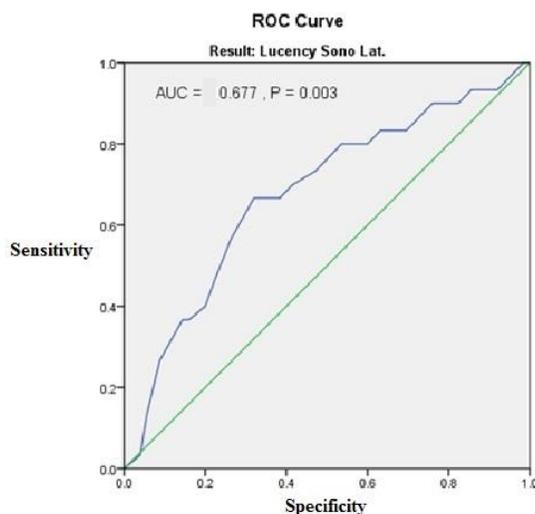


Fig. 5. AUC shows predictive value of lucency in the lateral nasal bone according to the elapsed time from trauma.

DISCUSSION

In the present research, 90 patients with nasal fracture who had referred to the Shohada-Ashayer hospital of Lorestan province (southwest of Iran) during two year were studied.

Adequate radiologic assessment of nasal fracture based on the injuries cause is obligatory for the possibility of legal consequences. For years the standard referral modality for nasal fracture diagnosis was considered to be CR, until some studies showed that CR had 25% false negativeness in patients with a documented nasal bone fracture. Although a conventional radiographic examination still remains the initial step for the radiologic assessment of nasal injury in many centers, but its efficacy and sensitivity in clinical decision-making is controversial; For instance sidewall injuries on conventional radiographies are difficult to be diagnosed [4]. The sensitivity of bilateral nasal bone radiographic view for the diagnosis of nasal bone fracture has been mentioned 75% in the literature [8]. Thiede et al. showed that even a 0.1 mm disruption of nasal bone can be detected by ultrasonography [2].

In a study on 63 patients, researchers found that the accuracy of sonography was superior to plain radiography in detecting nasal fracture line [10]. Danter et al. by evaluating 18 patients suffering from nasal trauma found out that the sensitivity and specificity of a 20 MHz ultrasonography comparing with physical examination were 83% and 50% respectively; They also showed that the sensitivity and specificity of HRUS compared to CR were 94% and 83% respectively [11]. Beck et al. studied 21 subjects suspicious for nasal fracture using a 5-7.5 MHz linear probe and found that all the fracture lines shown by CR were simultaneously detected by HRUS [4]. Zagolski and Streck showed that nasal bone fractures could be diagnosed exclusively on the basis of sonographic investigations [12]. A 14 MHz linear probe was used in the present study and the results were consistent with the results of studies carried out by Mohammadi et al. [13] and Thiede et al. [2]. Furthermore, our results were consistent with the results of Danter et al. [11] in which a 20 MHz probe was used to evaluate nasal bone fractures. It seems that a 14 MHz ultrasound head can detect nasal fractures just as well as 20 MHz ultrasound probe.

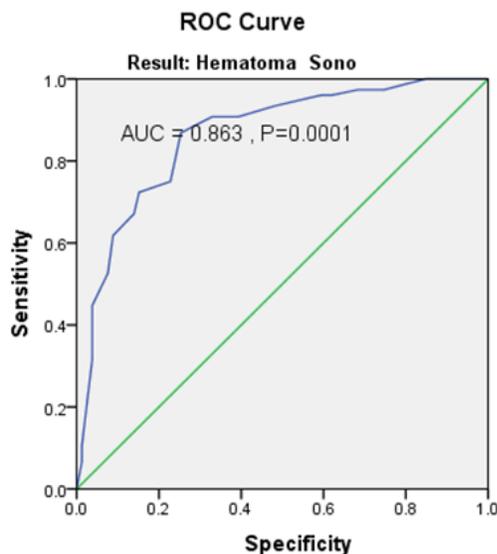


Fig: 6. AUC shows the predictive value of sub-periosteal hematoma of lateral nasal bone according to the elapsed time from trauma.

Danter et al. Study, also showed that sonography can show trauma of the cartilaginous part of the nose more exactly than conventional radiography [11].

Ultrasonography is an easy and accessible method that involves no radiation. Despite the many advantages of ultrasonography including low cost, lack of ionizing radiation and no patient preparation, it has several pitfalls; Above all, operator dependency and the projected external shape of the nose are the commonest limitations of sonography. For over-whelming these limitations, we used a hockey stick probe with a 14 MHz linear array transducer keeping contact between the probe and the nose. We found that during nasal trauma, lucency or stepping in the nasal septum can be detected in sonography which is usually missed in conventional radiographic studies. We also found that the sensitivity and specificity of ultrasonographic evaluations were not only the same but also even higher than CR in detecting lucency or stepping in the lateral nasal bone and this was compatible with previous studies [10]. Physical examination findings in nasal trauma are consistent for 10-14 days and conventional radiographic findings are consistent for years in 85% of patients [5]. In this study we found that among sonographic findings in nasal fracture, sub-periosteal hematoma and lucency in the lateral nasal bone are consistent for 25 and 85 days respectively, which has not been mentioned in previous studies.

CONCLUSION

Due to possible legal matters accurate imaging of nasal fractures in many circumstances is critical. The use of HRUS in the evaluation of fractures has increased. Considering the advantages of ultrasound such as the absence of ionizing radiation and ease of use and given the results of the present study, it is concluded that ultrasound can be an alternative primary technique in the diagnosis of nasal bone fractures, especially in pregnant women. The consistency of ultrasonographic findings in nasal fracture can be detected much more accurately than physical examination and conventional radiologic findings, so it is easier to determine the chronicity of nasal trauma by means of HRUS than Physical examination or CR.

Performing similar studies on larger groups of patients with shorter intervals between ultrasonographic investigations is suggested to confirm the afore-mentioned results.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

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FINANCIAL DISCLOSURE

The authors report no financial interests or potential conflicts of interest.

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