



Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

The accuracy of bedside USG in the diagnosis of nasal fractures☆

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ARTICLE INFO

Article history:

Received 28 February 2017

Received in revised form 12 May 2017

Accepted 13 May 2017

Available online xxx

ABSTRACT

A comparison of the sensitivity and specificity of bedside ultrasonography with conventional radiography for the evaluation of nasal fractures.

Introduction - purpose: There is increasing use of ultrasonography in the Emergency Dept (ED) and other areas. The purpose of the present study was to evaluate the sensitivity and specificity of bedside ultrasonography with conventional radiographs in the evaluation of nasal fractures in the ED.

Method: Patients admitted to ED with maxillofacial trauma were evaluated in this prospective study. Ultrasonography scans of the patients were taken by the emergency physician at the bedside. The images were obtained from both laterals and parallel to the nasal dorsum. The nasal radiography scans were evaluated by an experienced radiologist blinded to the study. The ultrasonography and radiography results were compared statistically. **Results:** The study included 103 patients. In showing the presence of nasal fracture, the sensitivity of ultrasonography was determined to be 84.8% (95% CI 71.13%–93.66%), specificity was 93.0% (95% CI 83.00%–98.05%), positive predictive value (PPV) was 90.7% (95% CI 77.86%–97.41%), negative predictive value (NPV) was 88.3% (95% CI 77.43%–95.18%).

Conclusion: Ultrasonography can be used in ED as an alternative method to conventional radiography with high rates of sensitivity and specificity in the evaluation of nasal fractures.

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1. Introduction

Patients with maxillofacial trauma are one of the most frequently seen patient groups in the Emergency Dept (ED) [1]. Nasal fractures constitute approximately 40% of the bone injuries that occur in patients with maxillofacial trauma as a result of prominent nasal anatomy and location [1].

Although nasal trauma is not a life-threatening situation, it can cause long-term serious disorders and medicolegal events if not diagnosed and treated in a timely manner. In recent years, there have been studies on the use of bedside ultrasonography (USG) in the diagnosis of various fractures (metacarpal, metatarsal, radius, phalanx) in EDs [2–6]. In these studies, USG has been shown to have high sensitivity and specificity. The hypothesis of this study was that bedside USG can be used as an alternative method to conventional radiography in the evaluation of nasal fractures in the ED.

☆ Author contributions: BC gathered data, made statistical calculations and wrote manuscript while SS, SA and GY made the literature search while AT checked the manuscript for scientific and grammar errors. IP supervised the conduct of data collection.

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2. Methods

This prospective study was conducted in the Emergency Medical Clinic of Izmir Bozyaka Training and Research Hospital of Izmir South Region Union of Public Hospitals. We aimed at least a hundred patients. Patients included in the study were those aged 16 years and older who presented at the ED with maxillofacial trauma between January 28, 2015 and April 30, 2016.

Patients with a nasal fracture history, those with unstable vital functions, over three days of trauma, pregnant women and patients with open wound on the nasal dorsum, or those who could not undergo USG because of a contamination risk arising from open fracture, were not included in the study.

Approval was granted by the Local Ethics Committee before beginning the study.

On presentation at the ED, patients were stabilized by the attending physician in accordance with the recommendations in the advanced trauma life support guidelines of the American Board of Surgery for trauma. Following completion of the examinations and necessary tests, the patients with maxillofacial trauma who were in a stable condition were informed about the study. A voluntary informed consent form



Figs. 1–2. Probe positions.

was obtained from the patients who agreed to participate in the study and the patient information was recorded on the data record form. The age, gender, type of trauma and USG findings of the patients were recorded on the study data form. The types of trauma were classified in 3 groups as assault, fall and traffic accident.

The bedside USG evaluations used as the index test in the present study were applied with an ESAOTE Mylab 30 gold (Mylab 30 gold, Esaote, Toscana, Italy) portable ultrasonography device with a 12.5 MHz linear probe. The USG evaluations of the patients were made by an ED medical assistant with basic and advanced ultrasound training, who was blinded to the study and had emergency surveillance ultrasound experience on a minimum of 100 patients. In our clinic, bedside USG performance of emergency medicine residents are evaluated by attending emergency physicians and we have two ultrasonography device so perform ultrasonography every day. The ED bedside USG evaluations were performed with a 12.5 MHz linear probe on the dorsum and both lateral sides in such a way as to be parallel to the nasal dorsum of the patient and the probe maneuvered to trace the structure longitudinally (Figs. 1, 2). Patients determined with any discontinuity on the nasal bone cortex in any axis were accepted as positive in terms of nasal fracture and the findings were recorded on the data record form.

The conventional radiography lateral view images used as the reference method were obtained from the lateral aspect with a Samsung XGEO GC80 (Xgeo gc80, Samsung, Seoul, Korea) device with 74 kVp, 200 mA, 63 ms of dosage and were recorded with patient's id number in the Picture Archiving and Communication System (PACS). The nasal radiography images of the patients were evaluated by an experienced radiologist blinded to the study and the results were recorded on the data record form.

The reason why computed tomography is preferred as the gold standard is not to expose patients to radiation, but for the diagnosis of nasal fracture only, it is not cost effective.

2.1. Statistical analysis

The conformity of the data to normal distribution was evaluated with the Shapiro-Wilk test, while the variance homogeneity was evaluated with the Levene test. The Independent-Samples *t*-test was used in the comparison of two independent groups according to quantitative data and the Pearson Chi-Square test was used in the comparison of qualitative data. The variables were analyzed at 95% confidence level and a value of $p < 0.05$ was accepted as statistically significant.

3. Results

A total of 117 patients met the study inclusion criteria but consent was only received from 104; 9 patients did not wish to participate in the study and 4 patients had an open fracture. Due to non-optimal nasal radiography, 1 further patient was excluded, leaving a total of 103 patients for evaluation.

Of the 103 patients included in the study, 48 (46.6%) were female, in the age range of 16 to 78 years. According to the trauma etiology, 53 (51.45%) patients presented at the ED following a fall, 45 (43.7%) because of an assault, and 5 (4.8%) because of a traffic accident (TA).

Considering the relationship between the results of ultrasonography and radiography methods in the nasal fracture detection of the patients, the nasal fractures of 43 (41.7%) of the 103 patients included in the study were detected with ultrasonography (Figs. 3, 4). The nasal radiography results of the patients, fractures were determined in 46 (44.7%) patients (Table 1). Those who were determined to have fractures in their radiographies were consulted by the attending physician.

The sensitivity of USG in showing the existence of nasal fracture in this study was determined to be 84.8% (95% CI 71.13%–93.66%). The specificity of USG was determined to be 93.0% (95% CI 83.00%–98.05%). The positive predictive value (PPV) of USG was determined

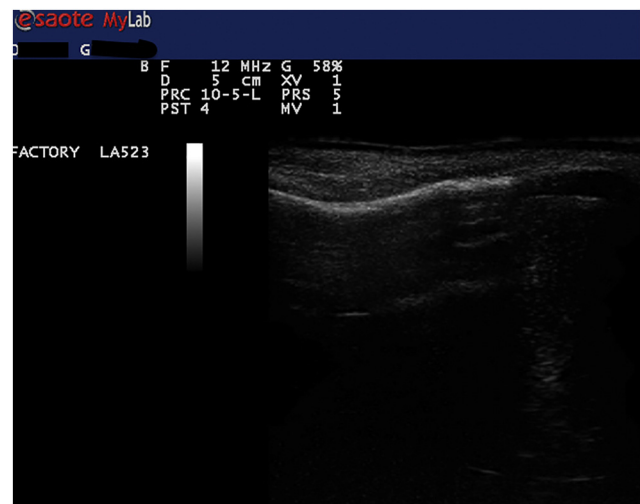


Fig. 3. Ultrasonography images of normal nasal bone.

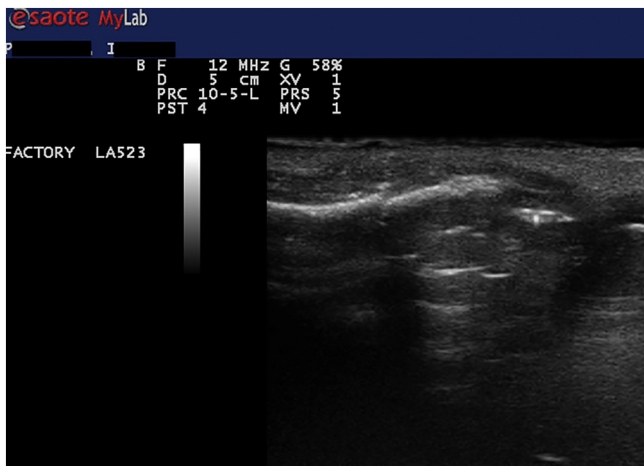


Fig. 4. Ultrasonography images of nasal bone fracture.

to be 90.7% (95% CI 77.86%–97.41%). The negative predictive value (NPV) of USG was determined to be 88.3% (95% CI 77.43%–95.18%). The relationship between USG and radiography was determined to be statistically significant ($p < 0.001$) (Table 1).

4. Discussion

The use and areas of use of USG in the ED are currently increasing. Various protocols have been developed for the evaluation of trauma patients. The use of bedside USG for trauma patients in the ED began with FAST and was supported in time by studies on bones in localized traumas.

There are studies in literature on the use of USG in metacarpal, distal radius and metatarsal fractures.

In a study by Aksay et al. in 2013 of 81 patients with a 5th metacarpal fracture, the sensitivity of USG was determined as 97.4% and specificity as 92.9% [4]. In a later study in 2015 by Kozacı et al. of 66 patients with metacarpal fractures, the specificity of USG was found to be 92% and sensitivity, 87%, compared to direct radiography [5].

In a study by Sabzghabaei et al. in 2016 on the reduction of distal radius fractures of 130 patients, it was seen that the use of USG reduced the need for secondary reduction (9.2% vs. 24.6%) [6].

Although there has been no previous study specifically related to bedside USG and nasal fracture in the ED patient population, there have been studies of the use of USG in nasal fracture diagnosis.

In a study of 80 patients in 2008, Gürkov et al. determined the sensitivity of USG over the nasal dorsum as 98% and specificity as 95%, while in the images obtained from both lateral walls, sensitivity was 98% and specificity 75% [7].

In a study by Hong et al. of 26 children in 2007, all 14 patients were evaluated to have fracture on radiography and were also determined to have a fracture on USG [8] and the other study by Lee et al. of 140 patients in 2009, determined sensitivity and specificity of high resolution ultrasonography with hockey stick probe as 100%, while on radiography and computed tomography's sensitivity as 78.3%, 92.8% and specificity as 100%, 50% [9].

In 2014, Atighechi et al. determined that nasal fracture was significantly diagnosed more in ultrasonography than in radiography on the lateral view on 128 patients ($P = 0.028$) [10] and Javadrashid et al. in 2011, study on Comparison of ultrasonography with computed tomography in the diagnosis of nasal bone fractures on 40 patients, the sensitivity of USG was determined as 94.9% and specificity as 100% [11].

In the present study, the sensitivity and specificity values of the bedside USG performed by emergency service physicians in showing the nasal fracture were found to be close to the sensitivity and specificity values of other studies performed by radiologists, plastic surgeons and otolaryngologists.

In the literature, the other important advantages of USG have been reported to be that sensitivity and specificity values have been found to be close to those of CT, patients can be diagnosed and treated faster as ED physicians with USG training can perform the evaluation, the duration of stay in the ED is shorter, there is no exposure to ionized radiation, no preliminary preparation is required, the application can be performed by any physician examining the patient, it can be done from different angles and is repeatable, documentable, portable and affordable [12–14]. However, as the most important disadvantage of USG is that it is operator-dependent, it was performed by a single physician in this study.

4.1. Limitations

Although the physician who performed the study had sufficient general USG experience, he had no extra experience of maxillofacial USG. The probe used in the current study was 12.5 MHz in frequency and it could be considered that if a higher-frequency transducer (e.g., 20 MHz) were to be used, better results may be obtained [14]. If the computed tomography is preferred instead of conventional radiography that may be more accurate, and some fractures may have been missed on radiography.

Being a single site study was a limitation of this study and multicenter studies are need to confirm our findings and overcome convenience sampling.

In conclusion, the findings of this study demonstrated that nasal bone fractures could be diagnosed with high sensitivity and specificity using bedside USG performed by ED physicians.

Table 1 Relationship between ultrasound and radiography results.

		Radiography (XR) (gold standart)				Total n	p value
		Fracture +		Fracture –			
		n		n			
USG	Fracture +	39	90,7% 84,8%	4	9,3% 7,0%	43	<0,001
	Fracture –	7	11,7% 15,2%	53	88,3% 93,0%	60	
	Total	46	44,7% 100,0%	57	55,3% 100,0%	103	

- Sensitivity
- Specificity
- Pozitif predictive value (+PPV)
- Negative predictive value (-PPV)

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