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Use of Bedside Ultrasonography for Diagnosis of Nasal Fractures in Emergency Service

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Abstract

Aim: In our study, the reliability of bedside ultrasonography (USG) in fracture diagnosis was evaluated in the cases who applied to emergency service due to nasal traumas.

Materials and Methods: Forty cases presented to the emergency department with nasal trauma between 01.01.2016 and 31.12.2017 were evaluated prospectively. The patients' age, gender, physical examination findings, trauma type, causes of trauma, X-ray and USG results were recorded in the study. The physical examination was performed by an emergency medicine specialist, and physical examination and X-ray were accepted as the gold standard for diagnosis. In patients with suspected nasal fracture, physical examination and X-ray results were compared with USG in fracture diagnosis.

Results: The median age of the patients was 32.5 [interquartile range (IQR): 31], and 72.5% were male. There was no correlation between fracture presence with age or gender ($p>0.05$). The most common findings were swelling (62.5%) and ecchymosis (47.5%). 77.5% of patients had isolated trauma, and the most common cause of injury was falls (52.5%). There was no correlation between the presence of fracture with the cause of trauma and the type of trauma ($p>0.05$). The sensitivity, specificity, positive predictive value and negative predictive value of USG were identified as 88.5%, 78.6%, 88.5% and 78.6%, respectively

Conclusion: Bedside USG can be preferred as the first choice in diagnosing nasal fracture in patients applying to the emergency service due to nasal trauma.

Keywords: Nasal fractures, emergency service, bedside ultrasonography

Introduction

Compared to other maxillofacial structures, the nose is an area that is prone to trauma due to its excessive protrusion (1,2). In maxillofacial traumas, nasal fracture is the most common with a rate of 40%-58% (3,4). Detection and correction of nasal fracture accordingly is cosmetically and clinically important for the future (1,5). Although physical examinations are considered gold standard for diagnosing nasal fractures, it is known that hematoma and edema of adjacent tissues make the diagnosis difficult (2). Imaging methods are often used in emergency service both for this cases and medico-legal reasons. Even though generally X-ray is used for imaging, gold standard is computerized tomography (CT). However, use of CT imaging for isolated nasal fractures in emergency service settings is not common. Ultrasonography (USG) is an easy, inexpensive, mobile and radiation-free diagnostic method that is frequently used in many areas of trauma. Recently, USG has been reported to be useful in detection of the presence of fracture in maxillofacial injuries (6). In last two decades, use of bedside USG in emergency service steadily increased and there have been studies on the use of bedside USG in the diagnosis of various fractures (metacarpal, metatarsal, radius, phalanx) in emergency department (7-9). In these studies, USG has been

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shown to have high sensitivity and specificity.

The aim of this study was to report the value of bedside USG for identification of nasal fractures in patients who apply to emergency service due to nasal trauma by correlating clinical findings and X-ray.

Materials and Methods

After the approval of the local ethics committee of Ankara Numune Training and Research Hospital (approval number: E-15-691, date: 23.12.2015), our study was conducted prospectively in 40 patients in accordance with Helsinki Declaration. The study was conducted according to the criteria set by the World Medical Assocation Declaration of Helsinki 'Ethical Principles for Medical Research Involving Human Subjects'.

Our study was performed in patients who presented to the emergency department with nasal trauma and received X-ray and USG imaging due to suspicion of nasal fracture after physical examination between dates of 01.01.2016 and 31.12.2017. Age, gender, physical examination findings, trauma type and causes of trauma were evaluated in the study. In our study, we created a "composite gold standard diagnosis" using the findings of physical examination (crepitation and/or dislocation) and X-ray for detection of nasal fractures diagnosis, then we compared the results of physical examination and X-ray with USG.

Specificity, sensitivity, positive predictive value (PPD) and negative predictive values (NPD) of USG were calculated. Nasal USG was performed by a radiologist (with 15-years of experience) in patients who gave consent. Ultrasonography and direct radiography were evaluated by radiologists separately. A linear probe (ToshibaAplio500, Nasu, Japan) at 4-11 Mhz frequency was used for ultrasonography measurement. A water balloon was placed between the nose and the probe to get a better image (Figure 1).

The presence of cortical separation and staging in the nasal bone was considered significant for nasal fracture (Figure 2, Figure 3).

The reason why computed tomography was not preferred in this study even though it is gold standard was not to expose patients to radiation and for sole purpose of diagnosis of isolated nasal fractures it is not cost-effective.

Patients under 18 years of age, patients who refused to give consent, patients with open wound on the nasal dorsum and who had nasal fracture previously were excluded from the study.

Statistical Analysis

The data obtained were analyzed using Statistical Package for Windows version 22 (SPSS version 22). The distribution of the quantitative data was done by Kolmogrov-Smirnov test. In the representation of quantitative nonparametric data, median and inter-quantile range (IQR) were used, while the number of cases (n) and percentile (%) were used for the representation of qualitative data. The Mann-Whitney U test was used for the comparison of the quantitative data with the qualitative (categorical) data, the Pearson's square test and Fisher's exact test were used for the comparison of the qualitative data with each other. $p<0.05$ was considered significant.

Results

The median age of the patients was 32.5 (IQR: 31); and 72.5% were male in our study. There was no correlation between fracture presence with age or gender ($p>0.05$). The most common findings were swelling (62.5%) and ecchymosis (47.5%). 77.5% of

Figure 1. Nasal ultrasonography was performed using water balloon in supine position with 4-11 MHz linear probe

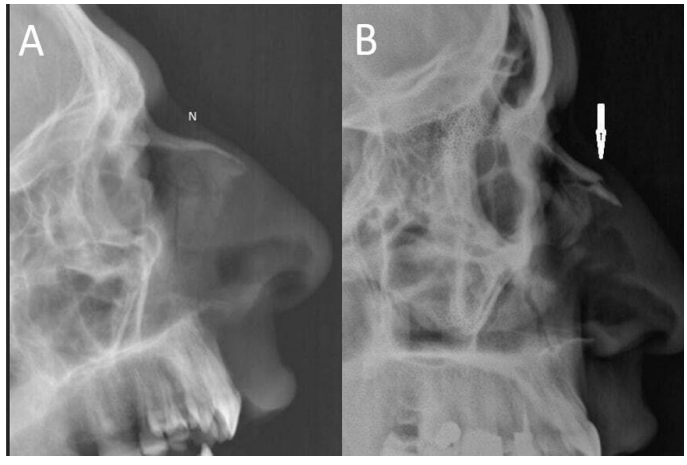

Figure 2. X-Ray Lateral Nasal view. Normal nasal bone formation is seen (A) and cortical separation and staging of the anterior nasal bone is observed (B)

the patients were injured due to isolated trauma and 22.5% due to multi-trauma. The most common injuries were due to falls (52.5%), followed by assaults (32.5%) (Table 1).

The frequency of crepitations was significantly low in patients who was diagnosed with a fracture ($p<0.05$). There was no correlation between the presence of fracture with the cause of trauma and the type of trauma ($p>0.05$) (Table 1).

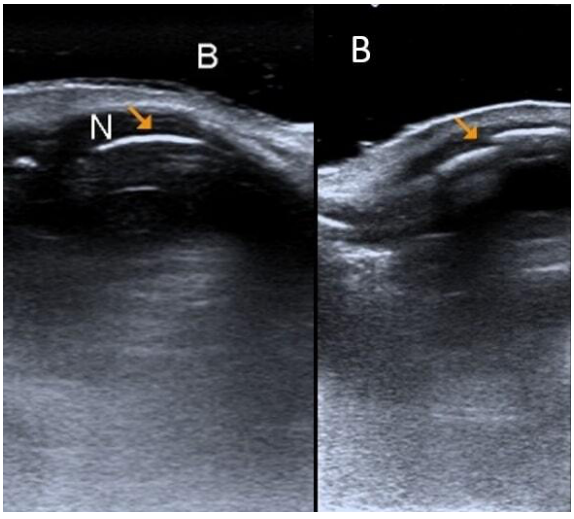

Figure 3. Normal nasal bone sonographic examination is seen on the right image. On the left image, cortical separation and staging was detected secondary to nasal fracture (B: Baloon Water, N: Normal).

In patients whose fractures were identified with physical examination and X-ray, USG sensitivity, specifity, PPD and NPD were 88.5%, 78.6%, 88.5% and 78.6%, respectively (Table 2).

Discussion

Ultrasonography is inexpensive, easy and non-invasive and allows high contrast imaging of even thin nasal bones at an appropriate frequency. In addition, high lateral resolution makes imaging of the smallest fractures and dislocations possible (10).

Studies have reported that patients presenting with nasal fracture are usually young males (4,6,11,12). Mozeika et al. (13) stated that maxillofacial injuries are frequently seen in young men. In our study, the incidence of nasal trauma and fracture was more frequent in young male patients in accordance with the literature. In our study, no significant relationship was found between the presence of fracture with age or gender.

Aksakal et al. (11) reported that swelling (70.2%) and hematoma (35.1%) were the most common findings (11). In the study of Doğan et al. (14) it is stated that the most common finding was swelling (51.1%) in children. In line with the literature, the most common symptom was swelling (62.5%), followed by ecchymosis (47.5%) and epistaxis (45%) in our study. We think that the edema occurs easily due to the protrusion of the nasal region and the absence of a structure to suppress the edema around this region.

Table 1. Demographic and clinical characteristics of patients with nasal trauma

		Whole population sample Yes (n=26)	Fracture		p-value
			No (n=14)		
Age, Mean ± SD		32.5 (31)	34.5 (29)	32 (36)	0.546*
Gender	Male, n (%)	29 (72.5)	19 (73.1)	10 (71.4)	>0.999***
	Female, n (%)	11 (27.5)	7 (26.9)	4 (28.6)	
Symptom	Swelling, n (%)	25 (62.5)	18 (69.2)	7 (50)	0.231**
	Ecchymosis, n (%)	19 (47.5)	10 (38.5)	9 (64.3)	0.119**
	Epistaxis, n (%)	18 (45)	11 (42.3)	7 (50)	0.641**
	Crepitations, n (%)	11 (27.5)	11 (42.3)	0	0.004***
	Deviation, n (%)	6 (15)	6 (23.1)	0	0.074***
Type of trauma	Isolated, n (%)	31 (77.5)	22 (84.6)	9 (64.3)	0.234***
	Multi trauma, n (%)	9 (22.5)	4 (15.4)	5 (35.7)	
Cause of Trauma	Falls, n (%)	21 (52.5)	13 (50)	8 (57.1)	0.309***
	Assault, n (%)	13 (32.5)	10 (38.5)	3 (21.4)	
	Traffic accident, n (%)	4 (10)	3 (11.5)	1 (7.1)	
	Collision, n (%)	1 (2.5)	0	1 (7.1)	
	Animal Kick, n (%)	1 (2.5)	0	1 (7.1)	

*Mann-Whitney U, **Pearson's chi-square test, ***Fisher's exact test

Table 2. Comparison of USG results to physical examination and X-ray

		Physical examination + X-ray fracture						p-value
		Yes (n=26)			No (n=14)			
USG fracture	Yes (n=26)	21	88.5%	88.5%	5	35.7%	35.7%	<0.001
	No (n=14)	5	19.2%	19.2%	9	78.6%	78.6%	
	Sensitivity							
	Specificity							
	Positive predictive value							
	Negative predictive value							

USG: Ultrasonography, n: Number

Aksakal et al. (11) reported that the most common cause of nasal injury was assault (40.5%) and falling (36.5%). Pham et al. (4) reported that nasal fractures usually develop as a result of blunt trauma (90.5%) and the most common causes were traffic accidents (27.5%) and falls (25.4%). It was reported that the most common cause of isolated fractures was falls in that study (4). Park et al. (1) reported that the most common cause of nasal fractures was fighting (40.6%). In our study, it was found that nasal injuries generally developed as a result of isolated injuries (77.5%), and the most common causes of injury were falls (52.5%) and assault (32.5). In our study, no significant relationship was found between the presence of fracture with the cause of trauma and the type of trauma.

Although tomography has been reported to be the best imaging tool for nasal fractures (5,6); many studies reported that USG and CT showed similar results in the detection of nasal fractures (1,2,5). Even though Lee et al. (5) reported that CT is much better than X-ray for detecting fractures; they also reported that USG has similar sensitivity to CT and better specificity for detecting nasal bone midline fractures, better PPV and NPV than CT. In the same study, it was reported that CT has more sensitivity than USG in detecting lateral nasal bone fractures (5). The fact that USG is better than CT in midline fractures has been attributed to thick-section CT images bypassing thin fracture lines (15).

In the study of Mohammadi et al. (16) sensitivity of nasal bone fracture detection rates for USG, CT and X-ray were 97%, 100% and 86% while specificity rates of USG, CT and X-ray were 87%, 72% and 73%, respectively. AL-Bahrany et al. (17) reported that the sensitivity of USG in nasal fractures was 76.6%. Lee et al. (5) found that sensitivity, specificity, PPV and NPV of USG according to localization of fracture were 70-80%, 75-90%, 50-72.7% and 86.4-93.3%, respectively. Caglar et al. (18) found that USG had a sensitivity of 84.8%, specificity of 93%, PPV of 90.7%, and NPV of 88.3% compared with radiography. Gürkov et al. (19) reported that compared to USG, the specificity of X-ray was higher for identification of lateral nasal bone fractures (75% and 94%). However, the sensitivity of USG for identification of fractures of lateral nasal bone were significantly higher comparing to X-ray (98% and 28%). In our study; sensitivity, specificity, positive predictive value and negative predictive value of USG were 88.5%, 78.6%, 88.5% and 78.6%, respectively. According to our results, USG had high sensitivity for identifying fractures of nasal bone, in line with the literature.

We think that bedside USG can be used as the first choice especially in cases where radiation is avoided such as pregnancy in the emergency department for the detection of nasal fracture with suspicious physical examination because it is repeatable, documentable, cost-effective and due to its non-radiation, no required preparation, rapid and bedside application.

Study Limitations

The most important limitation of our study was the small sample of cases. Another limitation which should mentioned was that we did not compare ultrasonography with CT which is the golden standard. This limitation stem from avoiding unnecessary radiation exposure and no requirement of additional imaging in existing traumas. Also, these results might not be confirmed in another center due to USG being operator-dependent.

Conclusion

We think that bedside USG can be preferred as the first choice in the diagnosis of nasal fracture in patients presenting to the emergency service with a nasal trauma, because of its high sensitivity in the diagnosis of nasal fracture. Further studies are needed on this subject.

There is no conflict of interest between the authors.

Ethics

Ethics Committee Approval: This study was approved by the Ethics Committee of Ankara Numune Training and Research Hospital (approval number: E-15-691, date: 23.12.2015).

Informed Consent: It was obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and/or Medical Practices: S.E., Concept: S.E., T.T.T., M.A., Design: S.E., T.T.T, Y.D., Data Collection and/or Processing: S.E., Y.D., H.M.Ç., Analysis and/or Interpretation: S.E., Y.D., M.A., Literature Search: S.E., T.T.T., Writing: S.E.

Conflict of Interest: No conflict of interest was declared by the authors.

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