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Accuracy of Ultrasound for Diagnosis of Femur Bone Fractures in Traumatic Patients

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Abstract

Objective: to evaluate the safety and applicability of the ultrasound diagnostic procedure in comparison to Radiography for detecting femur bone fractures in lower limbs.

Methods: We assessed 30 injured patients with suspected femur bones fracture that had presented to the ED. The patients were older than 18 years that transferred to the resuscitation room of the ED. Then, bedside ultrasound was performed for them. After the clinical conditions became stable, the patients were referred to the radiography unit for imaging. The findings are separately and blindly assessed, then would be compared with together. Sensitivity, specificity, the positive and negative predictive values and P-value were measured to appraisal the accuracy of ultrasound as compared with radiography (gold standard).

Results: The results of sensitivity, specificity, PPV and NPV for bones fracture of femur with linear array transducer of portable sonography and P-value not significant statistically. Sensitivity, positive predictive value and P-value for diagnosis of femur shaft fractures with deep array transducer of ultrasound were 90%, 47.3% and 0.0006 (<0.05), respectively.

Conclusion: In our study, evidences showed ultrasound is accurate equally to radiography for fractures diagnosis of shaft of femur in lower limb with deep array transducer of ultrasound in adults.

Keywords: Ultrasound; Radiography; Fractures diagnosis; Emergency unit

Introduction

Extremity injuries are among the most common reasons for visiting the ED. These injuries are significant and annual comprising approximately 3.5% visits to the ED all over [1]. It has been estimated traffic related death rate is approximately 1.2 million annually [2]. In recent years, there has been a progressive increase in the number of accidents involving motorcycle riders in large cities [3]. Some studies have shown that the main bone fractures found are orthopaedic ones, but the involvement of other body segments also perhaps occur [3,4]. It should be noted that the sequels secondary to this type of accidents are also such kind of drastic problems [4].

Fall-related bone fractures are among the most common, morbid, and expensive health conditions involving aged adults [5,6] so that includes 10% of ED visits and 6% of hospitalizations among patients over the age of 65 year-old [7]. Also, the occurrence of many limb fractures in individuals over age 50 year-old is explained by a fall [8]. In the elderly population, one-third of all them may fall at least once a year [5] and approximately 10% of these falls result in injuries that half of them are bone fractures [7].

Plain radiography is the ordinary standard of care for evaluation and diagnosis of long bone fractures [9], but the interest and possibility of using a non-invasive technique without exposure to ionizing radiation in bone fractures diagnosis has raised [2]. Ultrasound is rapid and cost-effective, and it has no adverse effects.

The aim of the present study is to compare the diagnostic accuracy of conventional radiography that considered as the gold standard and ultrasound for the diagnosis of suspected femur bone fractures in lower extremities in multiple trauma patients admitted to the ED with bone injuries.

Materials and Methods

This study is a single-blinded, prospective observational study for evaluation of diagnostic ultrasound against standard radiography. Our study was held for a one-year period from June 2014 until May 2015 and 30 multiple trauma patients presenting to the ED with a suspected femur bone fractures during this time. They were older than 18 years that admitted to the ED and then quickly had been conducted to the resuscitation room in the ED. The inclusion and exclusion criteria were used for patient selection that has been shown (Table 1).

Table 1: The inclusion and exclusion criteria for selection of patients.

Inclusion criteria	Exclusion criteria
Multiple trauma patients	Patients with clinically unstable situation who had been carried to the operating room for emergency surgical operation
Age 18 year-old or older	Patients with decreased Consciousness who could not localize their pain
They were clinically stable	Patients with manifest deformities showing fractures
They had not loss of Consciousness	Patients with evidence of open fractures
Patients presented with complaint of lower limb(s) trauma that had symptoms or signs of a possible femur bone fractures at any location along the bone in history and current examination	
They had no penetrating trauma	
They have required to radiography for evaluation	

This study began after approval by the Ethics Committee of Imam Khomeini Hospital Research Center. To perform this study, an emergency medicine proficient completed a 3-months musculoskeletal ultrasound course. At initial examination, a clinical assessment was made as to the possibility of femur bone fracture(s) in lower extremities and in suspected location(s) of the patients. The ED proficient performed bedside ultrasound on the bone in the lower extremities with particular punctuality over the areas with maximum pain or tenderness at longitudinal and transverse planes for all patients in a supine position after clinical assessment and prior to obtaining radiographs. Operator used a portable sonography (sonoACE R3 System, Samsung, South Korea) with a high frequency (10 to 15 MHz) broadband linear array transducer, which is used for screening soft tissues and bones. Also as regards great muscle tissues around femur bone, sonography of femur bones was performed with deep array transducer for patients with suspected femur bone fractures. When performing the ultrasound examination, we were looking for abnormalities of the cortex including a break, step-off, or discontinuity of the cortical margin at the fracture site. While doing initial management according to the trauma guidelines, the other members of trauma team took such actions like reduction, traction, and splinting based on the ultrasound findings. After the clinical signs had become stable, the patients were referred to the radiography unit for imaging. For this purpose, anteroposterior (AP) of pelvic, AP and lateral images of femur in addition AP, lateral and oblique images of knee joint were accomplish depending on the location that it was suspected to be fractured. After standard radiographies had performed, radiography images were interpreted by orthopaedic specialist without knowing from the results of sonography findings. The results of ultrasound and radiography evaluation were both defined as significant fracture, no significant fracture. In equivocal cases the result of plain radiography was dubious but there was likewise uncertainty to the fracture in such cases, CT (Computed Tomography) scan performed for patients. The results were recorded in separated forms and then, the results of the two diagnostic tests were compared with each other.

Statistical analyses were carried out with SPSS version 18. Incident or non-incident of fractures was respectively recorded as positive and negative results (Table 2).

Table 2: Characteristics of fractures and mechanism of trauma in studied patients.

Variables	Frequency (%)
Sex	
Male	21 (70.0)
Female	(30.0)
Mechanism of Trauma	
Car accident	7 (23.3)
Motor Accident	11 (36.6)
pedestrian	6 (20.0)
Falling	5 (16.6)
Under the rubble stay	1 (3.3)
Location of fracture in femur bone	
Proximal	12 (40.0)
Middle (diaphysis)	10 (33.3)
Distal	8 (26.6)
Side	
Right	19 (63.3)
Left	11 (36.6)
Dislocation	
Yes	18 (60.0)
No	12 (40.0)
Intra-articular	
Yes	4 (13.3)
No	26 (86.6)

Then, sensitivity, specificity, positive predictive values (PPVs), negative predictive values (NPVs) and P-value were used for the comparison between radiographic and ultrasound data. The

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results were calculated with the confidence intervals (CIs) of 95%. Qualitative data were presented as frequency and percentage. A P-value <0.05 was considered statistically significant. Because radiography is considered the criterion standard, sensitivity and specificity values were calculated for linear and deep probe of sonography.

Results

30 patients with the mean age of 40.2 ± 20.0 years were studied (70% male). Table 2 shows the characteristics of fractures and mechanism of trauma in studied patients. Based on these clinical results, radiography and ultrasound were conducted on those parts with suspected fractures.

Neither radiography nor ultrasonography showed any fractures in one patient, but patient have continuous pain, tenderness and limited range of motion. In this case, patient underwent CT scan, which confirmed fracture of distal femur.

Eventually, analysis was done on 30 sites of femur bone fracture, which were confirmed by plain radiography. 18 (60.0%) cases of fracture were dislocated and 4 (13.3%) were intra-articular. Table 3 shows characteristics of ultrasonography in detection of femur bone fractures. Based on these results, Prevalence of true positive and false negative detected cases for fractures by deep probe of ultrasonography were 9 (90%) and 1 (10%) for middle part (diaphysis) of femur fracture, respectively (Table 3).

Table 3: Characteristics of ultrasonography (linear and deep probe) in detection of different parts of femur bone fracture (+) (++).

Location of femur fracture	**True Positive N (%)**		**False Negative N (%)**	
	Linear probe of ultrasound	Plain radiography	Linear probe of ultrasound	Plain radiography
Proximal	-	12 (100)	12 (100)	-
Middle (diaphysis)	-	10 (100)	10 (100)	-
Distal	-	7 (87.5)	8 (100)	1 (12.5)
	True Positive N (%)		False Negative N (%)	
	Deep probe of ultrasound	Plain radiography	Deep probe of ultrasound	Plain radiography
Proximal	2 (16.6)	12 (100)	10 (83.3)	-
Middle (diaphysis)	9 (90)	10 (100)	1 (10)	-
Distal	5 (62.5)	7 (87.5)	3 (37.5)	1 (12.5)

Also, The sensitivity, specificity, positive predictive value, negative predictive value with CI 95% and P-value for diagnostic accuracy of deep array transducer of ultrasound for femur bone fractures compared with radiography attained that has been shown (Table 4).

Table 4: Accuracy of deep array transducer of ultrasound in diagnosis of femur bone fractures compared with radiography.

Fracture site	**Location of fracture**	**Sensitivity (CI 95%)**	**Specificity (CI 95%) (+)**	**Positive predictive value (CI 95%)**	**Negative predictive value (CI 95%) (+)**	**P-Value**
Femur	Proximal	16.6% (2.0-48.4)	8.3% (0.2-38.4)	15.3% (1.9-45.4)	9.0% (0.2-41.2)	>0.05
	Middle	90% (55.5-99.7)		47.3% (24.4-71.1)		0.0006
	Distal	62.5% (24.4-91.4)		38.4% (13.8-68.4)		0.20

Based on these results, sensitivity, positive predictive value and P-value for diagnosis of femur shaft fractures were 90% (55.5-99.7), 47.3% (24.4-71.1) and 0.0006 (<0.05), respectively.

Discussion

Plain radiography is the ordinary standard of care for evaluation and diagnosis of long bone fractures [9]. Studies have shown that often the imaging obtained is unnecessary and results in radiation exposure to patients and increase ED wait times [10]. Although exposure to high dose ionizing radiation is known to be carcinogen and teratogen, but the harmful effects of low dose ionized radiation are debated [11,12]. This is from particular subject in vulnerable groups such as children whose tissues are more sensitive to the radiation compared with adults [13] and during pregnancy [14]. Also, another concern is the risk of transferring critical patients to the radiography unit for imaging [9]. Also in remote areas such as submarines or Antarctica, radiography may not even be available [15]. Therefore, alternative imaging techniques should be considered.

The use of ultrasound has increased significantly over the last decade. During this period, focus has swerved toward using ultrasound in the ED and in the pre-hospital setting [16,17]. The E-FAST (Extended Focused Assessment Sonography in Trauma) is affirmed as well as using in patients with major trauma [18]. Additional emergency use of ultrasound includes diagnosis of pulmonary problems in children, the evaluation of ophthalmic trauma and aid to achieve vascular access in the patients with hypovolemic shock [16,19]. Despite the use of radiography as gold standard in the evaluation of orthopaedic injuries, use of the bedside ultrasound has several potential supremacy than plain radiography include to desist from exposure with ionizing radiation in particular patients such as pregnant women and paediatrics, in the prehospital environments, and to reduce exposures of consecutive ionizing radiation due to radiographs following fractures reduction, extensive access, Affordable, and bing bedside [9,15,20-22].

Also, as regards sonography is performed by the clinician who has already examined the patients, it provides prompt diagnosis because physicians can rapidly incorporate sonography findings with initial evaluation of patients [23,24]. Ultrasound has demonstrated notable use in the evaluation of extremity bone fractures in pediatrics, so that from initial diagnosis to guiding reduction of long bone fractures, sonography has shown promise in its ability to aid in the evaluation and treatment of fractures [25]. Anyway, in another study was shown that bedside sonography is not a dependable method for diagnosis of upper and lower limb bones fracture than standard radiography in adults [26]. Fractures of long bones have peculiar emphasis, since squired by neurovascular involvement and bleeding, can result in notable morbidity [27] that early identification of fractures may be is effective to immediate treatment or pursuant decisions, and ultrasound may be a rapid and reliable method for diagnosis of these kinds of bone fractures.

In this study all fractures that were diagnosed with sonography, as well as were recognized with radiography and there were no fractures diagnosed for us and those were missed by radiology. Previous studies have shown bedside ultrasound by trained clinicians is as impressive as radiography for diagnosis of long bones fracture. Patel et al. [28] showed ultrasound is useful as radiography for diagnosis of long bone fractures, and has a high sensitivity for diagnosis of such fractures. Haddad-Zebouni et al. [29] showed the high accuracy of bedside ultrasound for diagnosis of bone fractures and recommended that ultrasound be performed for diagnosis of fractures. Also, hübner et al. [30] found that diagnosis of long bone fractures using ultrasound is accurate in majority of cases. In versus, Bolandparvaz et al. [25] showed that ultrasound for diagnosis of long bone fractures was not dependable adequate, but results of this study expressed for long bone fractures, seamlessly, no in different segments of every bone.

Majority of studies have conducted studies on children [20,28] and others. Ultrasound is a reliable method for diagnosis of upper and lower limb bones fracture in children [29]. Some studies show that accuracy of ultrasound for diagnosis of minor fractures of bones and joints are highly enough [30,31]. Despite of the benefits pointed, ultrasound accuracy depends on the operator and can be used under special conditions [15]. Only two studies were done on adults who were conducted by Marshburn et al. [15] and Bolandparvaz et al. [26], in which the first study has shown that ultrasound is dependable only when an injury cannot be detected by radiography [15]. The second study has shown ultrasound had no sufficient specificity and predictive value for diagnosis of long bone fractures in adults [26].

The present study tried to assess the diagnostic accuracy of ultrasound as an alternative for x-ray. We found that ultrasound alone had a low diagnostic value in comparison with standard radiography while femur bones were checked with linear probe of ultrasound.

Also, in survey of suspected femur bone fractures with deep array transducer of ultrasound was shown sufficient diagnostic value in femur shaft fractures compared with radiography. Heretofore, no studies had been done for evaluation of femur fractures with deep probe of ultrasound. Because of the much soft tissue in thigh around femur bones, it seems deep transducer of ultrasound is more useful than linear transducer for evaluation of suspected femur bone fractures, but further studies need to be done in this field with more sample volumes. The study showed that ultrasound is reliable for diagnosis of fractures in shaft of femur that give enough information about fragments of fracture that the orthopaedist's are able to successfully reduce and immobilize the fractures.

Low sample volumes and lack of control group are two important limitations of the present study, which undermine the generalizability of the results. Conforming to trauma guidelines, ultrasound can be helpful for evaluation of some cases such as intra-peritoneal fluid, organ damage and pneumothorax. It is recommended that more studies be performed in this regard to infer its role in trauma guidelines.

Conclusion

The present study, evidence showed that ultrasound have high sensitivity (90%) for diagnosis of fractures in shaft of femur in adults. However, we recommend further studies with a larger sample size for the role of ultrasound in diagnosis of long bones fracture.

References

1. McCaig LF, Nawar EW (2004) National Hospital Ambulatory Medical Care Survey: 2002 emergency department summary. Adv Data 340: 1-34.
2. World Health Organization. World report on road traffic injury prevention. Available from: http://www.who.int/ violence_injury_prevention/ publications /road_traffic/ world_report/ summary_en_rev.pdf.
3. Wick M, Muller EJ, Ekkernkamp A, Muhr G (1998) The motorcyclist: easy rider or easy victim? An analysis of motorcycle accidents in Germany. Am J Emerg Med 16: 320-323.
4. Kraus JF, Peek-Asa C, Cryer HG (2002) Incidence, severity, and patterns of intrathoracic and intra-abdominal injuries in motorcycle crashes. J Trauma 52: 548-553.
5. Tinetti ME, Speechley M, Ginter SF (1988) Risk factors for falls among elderly persons living in the community. N Engl J Med 319: 1701-1707.
6. Tinetti ME, Doucette J, Claus E, Marottoli R (1995) Risk factors for serious injury during falls by older persons in the community. J Am Geriatr Soc 43: 1214-1221.
7. Tinetti ME, Williams CS (1997) Falls, injuries due to falls, and the risk of admission to a nursing home. N Engl J Med 337: 1279-1284.
8. Kelsey JL, Browner WS, Seeley DG, Nevitt MC, Cummings SR, et al. (1995) Risk factors for fractures of the distal forearm and proximal humerus. The Study of Osteoporotic Fractures Research Group. Am J Epidemiol 135: 477-489.
9. Cross KP (2011) Bedside ultrasound for pediatric long bone fractures. Clin Pediatr Emerg Med 12: 27-36.
10. Stiell IG, Greenberg GH, McKnight RD, Nair RC, McDowell I, et al. (1992) A study to develop clinical decision rules for the use of radiography in acute ankle injuries. Ann Emerg Med 21: 384-390.

This article is available from: http://dx.doi.org/10.4172/2471-8416.100027

11. Borja-Aburto VH, Bustamante-Montes P, Garcia-Sancho MC, Villa-Romero AR (1990) Ionising radiation at low doses and cancer: epidemiological controversy. Rev Invest Clin 42: 312-316.

12. Grazer RE, Meislin HW, Westerman BR, Criss EA (1987) A nine-year evaluation of emergency department personnel exposure to ionizing radiation. Ann Emerg Med 16: 340-342.

13. Donnelly LF (2005) Reducing radiation dose associated with pediatric CT by decreasing unnecessary examinations. AJR Am J Roentgenol 184: 655-657.

14. Watson NA, Ferrier GM (1999) Diagnosis of femoral shaft fracture in pregnancy by ultrasound. J Accid Emerg Med 16: 380-381.

15. Marshburn TH, Legome E, Sargsyan A, Li SM, Noble VA, et al. (2004) Goal-directed ultrasound in the detection of long-bone fractures. J Trauma 57: 329-332.

16. Tirado A, Wu T, Noble VE, Huang C, Lewiss RE, et al. (2013) Ultrasound-guided procedures in the emergency department diagnostic and therapeutic asset. Emerg Med Clin North Am 31: 117-149.

17. Heegaard W, Hildebrandt D, Spear D, Chason K, Nelson B, et al. (2010) Prehospital ultrasound by paramedics: results of field trial. Acad Emerg Med 17: 624-630.

18. Rippey JC, Royse AG (2009) Ultrasound in trauma. Best Pract Res Clin Anaesthesiol 23: 343-362.

19. Kubal WS (2008) Imaging of orbital trauma. Radiographics 28: 1729-1739.

20. Hübner U, Schlicht W, Outzen S, Barthel M, Halsband H (2000) Ultrasound in the diagnosis of fractures in children. J Bone Joint Surg Br 82: 1170-1173.

21. Saul T, Ng L, Lewiss RE (2013) Point-of-care ultrasound in the diagnosis of upper extremity fracture-dislocation. A pictorial essay. Med Ultrason 15: 230-236.

22. Blankstein A (2011) Ultrasound in the diagnosis of clinical orthopedics: The orthopedic stethoscope. World J Orthop 2: 13-24.

23. Wakefield RJ, Balint PV, Szkudlarek M, Filippucci E, Backhaus M, et al. (2005) Musculoskeletal ultrasound including definitions for ultrasonographic pathology. J Rheumatol 32: 2485-2487.

24. Geusens E, Pans S, Van Breuseghem I, Brys P (2002) Ultrasound in acute trauma of the ankle and hindfoot. Emerg Radiol 9: 283-288.

25. Balaram AK, Bednar MS (2010) Complications after the fractures of metacarpal and phalanges. Hand Clin 26: 169-177.

26. Bolandparvaz S, Moharamzadeh P, Jamali K, Pouraghaei M, Fadaie M, et al. (2013) Comparing diagnostic accuracy of bedside ultrasound and radiography for bone fracture screening in multiple trauma patients at the ED. Am J Emerg Med 31: 1583-1585.

27. Advanced trauma life support for doctors. Student course manual, 6th edtn. Chicago: American College of Surgeons; 1997:95.

28. Patel DD, Blumberg SM, Crain EF (2009) The utility of bedside ultrasonography in identifying fractures and guiding fracture reduction in children. Pediatr Emerg Care 25: 221-225.

29. Haddad-Zebouni S, Abi Khalil S, Roukos S, Menassa-Moussa L, Smayra T, et al. (2008) Limb fractures: ultrasound imaging features. J Radiol 89: 557-563.

30. Hauger O, Bonnefoy O, Moinard M, Bersani D, Diard F (2002) Occult fractures of the waist of the scaphoid: early diagnosis by high-spatial-resolution sonography. AJR Am J Roentgenol 178: 1239-1245.

31. Fusetti C, Poletti PA, Pradel PH, Garavaglia G, Platon A, et al. (2005) Diagnosis of occult scaphoid fracture with high-spatial-resolution sonography: a prospective blind study. J Trauma 59: 677-681.