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Original Article

Early scaphoid fractures are better diagnosed with ultrasonography than X-rays: A prospective study over 114 patients

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ABSTRACT

Purpose: Wrist has a complex anatomy and undergoes complex injuries. Scaphoid fracture is one of such injuries. It is the most common fracture in carpal bone. Most of the scaphoid fractures are missed on initial X-rays. Magnetic resonance imaging (MRI) is considered as a gold standard for diagnosing scaphoid fractures. Ultrasonography (USG) is emerging as a good alternative to make an early diagnosis of scaphoid fractures. Our aim is to throw light upon the role of USG in detection of scaphoid fractures.
Methods: The study was centered upon 114 patients in the age range 10–65 years, with traumatic wrist injury and were clinically suspected to have scaphoid fractures. Patient with non-traumatic history, bilateral wrist injury and late presentation were excluded. X-rays, USG using high frequency probe and MRI were done for all patients. MRI was considered to be the gold standard test. Patients were followed up at 6 weeks.
Results: Of the 114 patients, X-ray could diagnose scaphoid fractures in 48 patients, 30 of which were confirmed by MRI. USG results were positive in 74 patients, of which MRI was positive in 67 patients. The accuracy of scaphoid fracture detection with USG was 98.04% in comparison to X-ray (20.58%), which was statistically significant.
Conclusion: USG provides a more accurate and reliable method of making an early diagnosis of scaphoid fracture than X-rays. It is non-invasive, non-expensive and allows better visualisation of cortical disruption.

Introduction

The hand and wrist constitute very important functional parts of the body used in daily life activities. So these are very much vulnerable to traumatic injuries. 6.6%–28.6% of all injuries and 28.0% of all musculoskeletal injuries comprise injury to wrist and hand.[1,2] Wrist injuries are a bit commoner than hand injuries. Schoffl et al[3] reported that these injuries accounted for 14.0%–30.0% of all patients being treated in emergency room. Though these injuries never threaten life, early diagnosis is always necessary, so that the appropriate treatment can be started as early as possible. Accurate diagnosis can be made with proper clinical examination and should be confirmed with imaging before any treatment is advised. Radiographs remain the investigation of choice for arriving at diagnosis when injury occurs. Specialised views are required to visualise all aspects of wrists and hand. Above all, clinical correlation is equally significant. If the findings on radiographs and clinical examination are not correlating, one should prefer other imaging modalities. Ultrasonography (USG), magnetic resonance imaging (MRI), and computed tomography (CT) are other such imaging techniques, which provide accurate diagnosis that are often missed on X-rays. Many studies consider that with MRI, occult scaphoid fractures could be diagnosed earlier.[4–6] MRI has a high sensitivity and specificity for scaphoid fractures not evident on X-rays.[7,8] Some consider MRI as the gold standard investigation for clinically suspected scaphoid fracture, and it allows diagnosis of occult bony and soft-tissue injuries.[9] High frequency USG has also been recommended to diagnose occult scaphoid fractures.[10] The criteria used for USG detection of scaphoid fractures were cortical disruption and wrist effusion.[11]

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The objective of our study is evaluation of traumatic wrist injuries using ultrasonography, and making an early diagnosis of scaphoid fractures. Scaphoid is the most frequently fractured carpal bone.[12] The most common mechanism of injury is a fall onto an outstretched hand. Wrist pain, swelling and tenderness over anatomical snuffbox on clinical examination raise the suspicion of scaphoid fracture. Most of the scaphoid fractures are occult on presentation and often missed on initial radiographs. USG is economic and a non-invasive imaging modality, which uses higher frequency sound waves that are normally not audible to human beings.[13] These higher frequencies provide better resolution and improved spatial detail. We have evaluated 114 patients with traumatic wrist and hand injuries in our study and they were subjected to digital X-ray, USG, and MRI. MRI has been considered as gold standard in our study.

Methods

A total of 146 patients in the age group of 10–65 years with traumatic wrist injuries were evaluated. Of these, 114 agreed to participate in the study. Written and informed consents were taken. The patients presented with complaints of pain, swelling or restricted movements of wrist joint or tenderness in anatomical snuffbox in the outdoor patient department of author's institute and had a clinical suspicion of scaphoid fracture. Patients with bilateral involvement, non-traumatic history and presenting after a week from trauma were excluded from the study. Detailed history was taken and bilateral wrist joint examination was done. Provocative tests included Scaphoid shift test (pain on volar-dorsal shifting of the scaphoid) and Watson shift test (pain on moving wrist from ulnar to radial deviation). Digital radiographs of involved wrist joint were then obtained. Standard radiographic views, neutral anteroposterior and lateral along with some special views for scaphoid, pronated oblique and posteroanterior in ulnar deviation of wrist were preferred. Advantages of views in two perpendicular planes are easy identification of bony landmarks and assessment of adjacent soft tissue structures.

Patients were then subjected to ultrasonography (USG) of the affected wrist. All USGs were reviewed by single radiologist to avoid intra-observer variability. The healthy side was used as control. USG was used along with extended field of view (EFOV) and colour Doppler technology whenever required. Use of such technologies allows clear visualisation of bones, joints, muscles, tendons, and even slightest inflammatory conditions. A linear array transducer of frequency 5–12 MHz (Million Hertz) was used in our study.

Patients was made to sit on a stool/couch facing the USG machine and asked to expose both the wrist joints up to the mid forearm simultaneously. Hand was placed appropriately for imaging specific areas of the wrist. Longitudinal, transverse, and EFOV images were obtained. The radiologist was asked to assess the cortical continuity of scaphoid and detect the presence of radiocarpal effusion. Signs suggestive of scaphoid fracture on USG were focal defect due to cortical disruption of scaphoid or hypoechoic fluid in the radio carpal space due to haemarthrosis. These signs were reported to be associated with scaphoid fractures.[11,14,15] Fig. 1 shows scaphoid fractures detected with USG in patients with normal X-rays.

All patients were then subjected to dedicated wrist MRI, which was considered to be the gold standard.

Results

The average age of patients was 32 years (range, 10–65years), with 65% patients between 20 and 40 year, 15% below 10 years, and rest 20% above 40 years. Male: female ratio was 2:1.75% of the patients were from the middle socioeconomic class, and remaining 25% were from the lower class. The chief complaints were pain, swelling and restricted wrist movements. Most of the patient presented with more than one complaint. 2% of the patient had deformity.

Digital X-rays, USG and MRI of the involved wrist joint were ordered for all patients upon initial presentation. Of the 114, 48 patients were diagnosed to have scaphoid fracture on X-ray

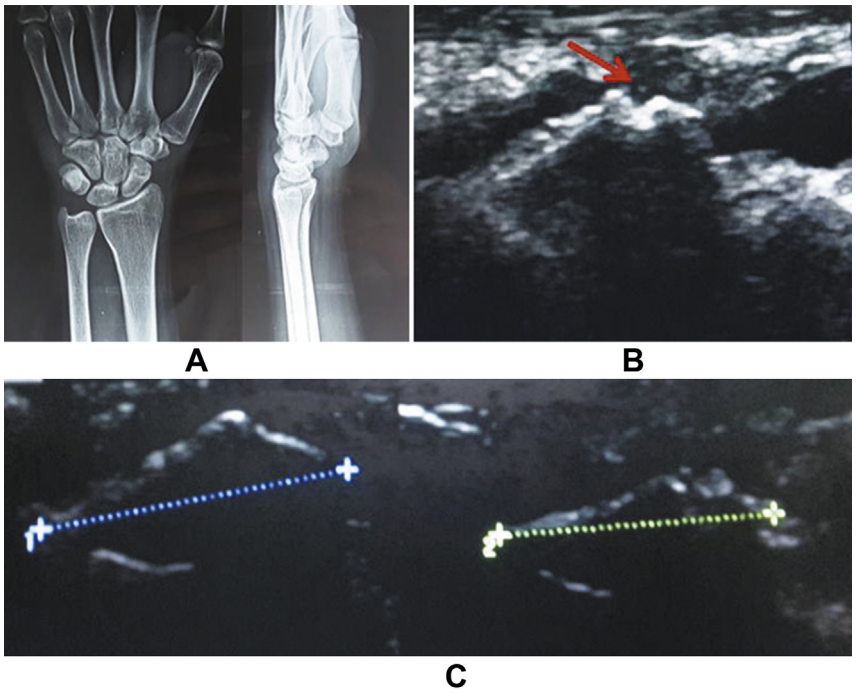

Fig. 1. A: Initial X-ray with normal findings. B: USG showing cortical disruption as pointed by arrow head. C: USG showing decreased width of fractured scaphoid due to impaction as compared to normal side (blue line-normal side, green line-affected side).

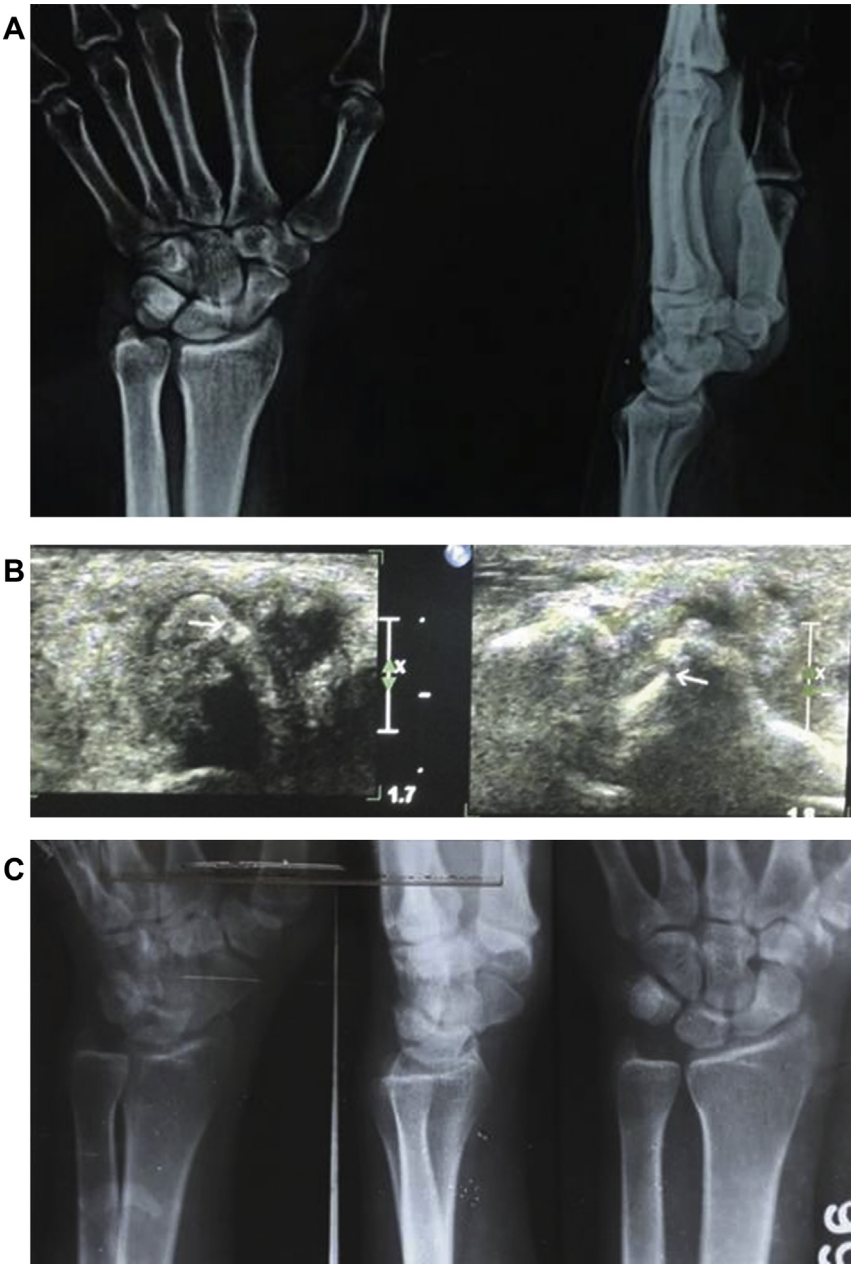

Fig. 2. A: Initial X-ray with no positive findings. B: USG showing cortical discontinuity of scaphoid pointed by arrow. C: X-ray after 6 weeks showing resorption of fracture site and callus formation.

findings, and 66 had normal radiographs. The patients were then subjected to USG of the local region (wrist joint). USG results were positive for 74 patients and rest 40 patients had normal USG (Fig. 2). MRI detected fractures in 84 patients.

Of the 48 X-ray positive results, MRI confirmation was positive for 30 (true positive) patients, and the rest 18 (false positive) were detected of no abnormalities. Of 66 X-ray negative patients, MRI confirmation was given for 12 (true negative) patients. Amongst 74 USG positive patients, MRI detected fracture in 67 (true positive) patients, and 7 (false positive) were normal. Of the 40 USG negative patients, 23 were true negative, and the rest 17 were false negative.

Tables 1 and 2 show the findings of X-rays and USG, respectively. The sensitivity of X-ray was 35.71% and that of USG was 79.76%. The specificity for X-ray and USG was 40.00% and 76.67% respectively and this difference is statistically significant. Table 3 compares the results of X-rays and USG, which was also found to be statistically significant.

All MRI confirmed scaphoid fractures were managed accordingly. USG findings in most of the patients with normal X-rays upon initial presentation revealed undisplaced or unicortical fractures,

Table 1
X-ray findings.

X-ray findings	MRI findings		X^2	p value
	Positive	Negative		
Positive	30	18	5.34	0.0200
Negative	54	12		

Table 2
USG findings.

USG findings	MRI findings		X^2	*p* value
	Positive	Negative		
Positive	67	7	28.407	0.0000
Negative	17	23		

Table 3
Comparison of results of X-ray and USG (%).

Item	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy
X-ray	35.71	40.00	62.50	18.18	20.58
USG	79.76	76.67	90.54	57.50	98.04

which were well managed conservatively with thumb spica cast for at least 6 weeks. Patients with >1 mm displacement, communited fractures, radio lunate angle >15°, and scaphoid-lunate angle >60° were candidates for operative management. After 6 weeks patients were followed up, and X-rays were repeated to look for signs of healing. Immobilisation and evaluation were continued until symptoms resolved or X-rays revealed resorption at fracture site or visible callus.

Fractures with significant displacement and communition were detected easily on initial radiographs and were managed accordingly.

Discussion

The ultrasound waves were earlier utilised for detecting icebergs and submarines during wars. Ultrasound techniques were first used for medical purpose in 1942.[10] Physicians in emergency department started utilising it for trauma evaluation in 1980's.[16–19] USG was found to be highly sensitive and specific for the bedside diagnoses of many diseases.[20–23] The availability of high frequency transducers and advanced technology of ultrasound equipment allows better evaluation of scaphoid fractures.[24]

In our study, we have compared the efficacy of USG with radiographs in early diagnosis of occult scaphoid fractures. USG was found to be more sensitive and specific for making an early diagnosis of scaphoid fractures, which are often missed on X-rays at initial presentation.

Platon et al[25] in their study concluded that the sensitivity of USG in diagnosing scaphoid fracture was 92%, and it is useful in patients with suspected scaphoid fracture but negative X-ray results. Hauger et al[26] used 12 MHz transducer in his study and reported that high resolution USG are reliable in making a diagnosis of occult scaphoid waist fractures. High resolution makes detection of cortical disruption easier and accurate. Fusetti et al[11] utilised criteria's like, cortical interruption, radio-carpal effusion, and scapho-trapezium-trapezoid effusion as indicators for scaphoid fractures, and concluded that high resolution USG provides a reliable and cost-effective method for early diagnosis of scaphoid fractures. Ultra sound has also been used in diagnosing fractures in children. Hubner et al[27] in their study on 163 children concluded that in several type of fractures in children, USG alone gave reliable information, and no further imaging was needed. USG plays a significant role in detecting other wrist pathologies like tenosynovitis, rheumatoid arthritis, tendinosis, tendon rupture etc.[13] Though USG also allows mechanical monitoring of fracture healing, X-rays remain the modality of choice in assessing union in scaphoid fractures by identifying trabeculae across fracture line.[28]

According to Taljanovic et al[29] CT allows better visualisation of fracture line, displacement and angulation of fracture fragments, and MRI without contrast is the investigation of choice for diagnosing occult scaphoid fractures. Bretlau[4] in his study concluded that scaphoid fractures can be diagnosed earlier, using dedicated-extremity MRI. Scaphoid fractures can be diagnosed with accuracy in the emergency department, with bedside USG. Though CT and MRI are more appropriate for diagnosing occult scaphoid fractures, their high cost and limited availability is a major obstacle for their application in clinical practise.[24]

Use of USG in evaluating wrist injuries not only saves time, but also provides a reliable diagnosis. Being cost effective, it can be afforded well by low socioeconomic class people. Scaphoid fracture is a commonly encountered wrist injury. Ultrasonography is highly accurate in diagnosing scaphoid fractures. We suggest that high resolution USG should be used in detecting occult scaphoid fractures that are often missed on initial X-rays, so that appropriate treatment can be started at the earliest. It allows to make an early and accurate diagnosis and the need of MRI and CT can be eliminated, which are more invasive, expensive, and time consuming.

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