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# The efficiency of bedside ultrasonography in patients with wrist injury and comparison with other radiological imaging methods: A prospective study☆,☆☆

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ABSTRACT

*Study objective:* Our aim was to determine the efficiency of ultrasound (US) scanning in patients with wrist trauma admitted to the emergency department and to compare US diagnostic usage with other radiological imaging methods.

*Methods:* Patients who presented to the emergency department with wrist injury and who met the inclusion criteria and exclusion criteria were eligible. For all patients, US evaluation of the whole wrist was performed by an emergency physician before other radiological imaging methods (radiographies, computed tomography (CT) and magnetic resonance (MR) imaging). All of the patients included in the study underwent US, radiography, CT, and MR.

*Results:* During the study, 122 patients were admitted with a wrist injury. After filtering for the exclusion criteria, 80 patients were included in the study. The sensitivity of US scanning in detecting fractures was 95.31% (95% confidence interval [CI]: 87.1–98.39), the specificity was 93.75% (95% CI: 71.67–98.89), and the positive predictive value was 98.39% (95% CI: 91.72–99.85), and the negative predictive value was 83.33% (95% CI: 72.98–90.41). The sensitivity of US scanning in detecting tendon and ligamentous structural injury was 66.67% (95% CI: 41.71–84.82), the specificity was 100% (95% CI: 94.42–100), the positive predictive value was 100% (95% CI: 94.29–99.89), and the negative predictive was 92.86% (95% CI: 84.25–97.14).

*Conclusion:* US scanning is an effective method that can be applied in the emergency department to adult patients to diagnose distal forearm and carpal bones fractures. In soft tissue injuries, US and MR examinations produce similar results.



## 1. Introduction

### 1.1. Background

The wrist and hand are the most important functional parts of the body in daily life activities and are prone to traumatic injuries [1]. These injuries constitute 6.6% to 28.6% of all injuries and 28.0% of all musculoskeletal injuries [2,3]. Wrist and hand injuries account for 14.0% to 30.0% of all treated patients in emergency care [4]. Although these injuries are not life-threatening, the accepted treatment strategy for traumatic injuries is the immediate reconstruction of all injured tissue structures [1]. In addition to the impact of hand and wrist injuries on physical and mental health, they can lead to high health-care costs and prolonged time off from work [5]. As a consequence, these injuries may impose a considerable economic burden on the community [5].

### 1.2. Importance

Fractures of the carpal bones are common after wrist trauma. Early diagnosis of these fractures is crucial to initiate appropriate therapy, which may help to prevent complications such as delayed healing, nonunion, pseudarthrosis, avascular necrosis, and arthrosis of the wrist [6]. However, immediately after injury, up to 20–65% of distal forearm and carpal bones fractures, especially scaphoid fractures, remain radiographically occult [6,7]. Soft-tissue injuries such as tendons and

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ligaments injuries cannot be defined in radiographies or computed tomography.

Computed tomography of the wrist are used in patients with persisting complaints or equivocal findings on plain radiographs, and difficult anatomical situations. Suspected ligamentous injuries of the wrist including tears of the triangular fibrocartilage complex are evaluated by wrist arthrography or magnetic resonance imaging [8]. Ultrasound is an imaging technique that has been used for many years to examine musculoskeletal tissues [14]. At the end of the 1980s, due to its therapeutic energy ranges and its characteristic of causing pain and a tingling sensation at the site of the fracture, US evaluation was introduced to diagnose fractures [15]. The development of high-resolution transducers has increased the capability of ultrasound to evaluate the normal structures of the musculoskeletal system as well as to detect and characterize subtle pathological changes [9]. US allows the detection of foreign bodies and the reliable identification of a variety of traumatic lesions affecting tendons, annular pulleys, ligaments, vessels and nerves [10]. Ultrasound is an efficient, rapid and inexpensive imaging technique for wrist evaluation [9,10]. Compared with MR, US has several advantages including comparative and dynamic imaging capabilities, higher spatial resolution, wider availability, and lower cost in detecting wrist tendons [16]. For successful US evaluation in terms of experience and the integrity of the whole examination, time will be needed. For prompt diagnosis, focused US on symptomatic parts of the body is preferable; to avoid leaving the possibility of another diagnosis open, routine wide-scope US examinations are preferred approaches [17]. Previous studies showed that many pathological examinations could be diagnosed with focused evaluation [18]. In addition to a comprehensive examination, focused US is increasing the rate of reported diagnoses.

Few studies showed that US sensitivity is 89.06–100% and specificity is 94.29–98% in diagnosing fractures in wrist region [22-23]. We can find one study reported in the literature about US sensitivity and specificity in diagnosing tendon and ligamentous injuries in wrist region. This study demonstrated that US sensitivity and specificity in diagnosing tendon and ligamentous injuries are 100% in this region [25].

### 1.3. Goals of this investigation

Our aim was to determine the efficiency of US scanning in patients with wrist trauma admitted to the emergency department and to compare US diagnostic usage with other radiological imaging methods (radiographies, CT, and MR imaging).

## 2. Methods

### 2.1. Study design

This was a cross-sectional, prospective study conducted from January 2014 to October 2014 in an academic emergency department. Written informed assent and consent was obtained from all participants. Approval for this study was granted by the local university institutional review board.

### 2.2. Setting

The physician applying US (primary physician) attended many musculoskeletal US workshops and congresses. Currently, training in US is part of the curriculum of our emergency medicine residency program.

Ultrasound, applied to all patients in emergency department, was performed in accordance with the European Society of Musculoskeletal Radiology, Wrist Ultrasound Technical Guidelines [11]. Ultrasonographic examinations were performed before other radiological imaging methods (radiography, CT, and MR). Ordering other radiological examinations and treatments of the patients were overseen by another physician. The clinician who performed the US did not see the other radiological imaging methods and their interpretations. Patients with wrist injuries had their wrist anteroposterior and lateral X-rays and ulnar deviation X-ray taken. CT analysis of the wrist joint was also performed in emergency department. Despite it is not a routine emergency department practice pattern, for evaluate soft tissue injury MR analysis of the wrist joint was performed all patients within five days after emergency department admissions. In this way, all of the subjects included in the study underwent ultrasonography, radiography, CT, and MR. At the end of the study, all of the radiological images were interpreted by an orthopedic specialist. The research study protocol did not disrupt the clinical management of the patients.

### 2.3. Selection of participants

During the study, the triage nurse made contact with the primary physician in charge of the study when a patient with wrist injury presented. In this way, the physician in charge of selecting the patients ensured that they met the inclusion criteria and exclusion criteria. Aged 16 or older, provided written consent, conscious and stable patients were included the study. Unstable, exposed to penetrating trauma, with open fractures and apparent dislocation, with chronic problems such as osteomyelitis, having contraindications for magnetic resonance imaging and pregnant patients were excluded the study.

### 2.4. Methods of measurement

The primary physician recorded the patients' sex, age, the cause of the injury (simple fall, sport injury, motor vehicle accident, assault, fall from height), and whether the injury was to the left or right wrist. Physical examination findings were recorded, and fractures of the bone structures and soft tissue (tendons and ligaments) injuries were immediately evaluated by the primary physician in charge. All data were imported into SPSS 15 for Windows (SPSS Inc., Chicago, IL).

The ultrasonographic images were obtained by a LOGİQ Book XP (General Electric, Logiq book XP, Turkey) device and linear probe (10 MHZ). The CT scan was performed using a Toshiba Asteion S4 (Toshiba Asteion 4, Toshiba Medical System, Japan) with four detectors. No oral or intravenous contrast matters were used. The MR scan was performed using a General Electric 450 W Optima (General Electric Company, USA) having 1.5 T 16 channels. No oral or intravenous contrast matters were used.

### 2.5. Analysis

Sample size was calculated based on a previous study in which there was a 13% difference in the identification of fracture between US and other radiological imaging methods [6]. By using this value to obtain the sample size, we determined that 70 patients was minimum sample size to yield a type I error of 0.05 and power of 90%.

Statistical analysis was performed with SPSS 15 for Windows (SPSS Inc., Chicago, IL). Descriptive statistics are shown as average + standard deviation for variables with a normal distribution, as median (min - max) for variables with an abnormal distribution and as the number of cases and (%) for nominal variables. Nominal variables were evaluated with Pearson Ki-Kare. In researching the harmony between classified values obtained by each method, the kappa correlation coefficient relevance was calculated. In researching method compliances, the sensitivity, specificity, false positive, false negative, positive likelihood ratio, negative likelihood ratio and 95% confidence intervals for each calculated. Results of $p < 0.05$ are accepted as statistically significant. In the study of bone structures, sensitivity and specificity values for US were calculated. CT is taken as the gold standard. In researching soft tissue, the sensitivity and specificity values for US were calculated. MR was taken as the gold standard.

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