

## ORIGINAL ARTICLE

# Role of high-resolution ultrasound examination in assessment of early undiagnosed hand pain

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### ABSTRACT

Keywords: Hand pain;  
Synovitis;  
Musculoskeletal  
ultrasound; Wrist pain.

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**Background:** Ultrasound (US) is a non-invasive method that enables differentiation between different causes of hand and wrist pain and evaluation of several joints during early disease and in mild symptoms. **Aim:** To assess the role of High-Resolution Musculoskeletal Ultrasound (MSUS) in diagnosis of early undiagnosed hand and wrist pain and their causes. **Patients and Methods:** A cross sectional study involved 100 patients with non-traumatic painful wrist. Appropriate clinical history and relevant laboratory findings (RA factor, ESR, CRP, anti CCP) were recorded. Musculoskeletal ultrasound (MSUS) of wrists and hands was performed. **Results** We found that synovitis was found in 69 (69%) patients, erosions in 28 (28%) patients, double contour sign in 6 (6%) patients, osteophytes in 33 (33%) patients, synovial hypertrophy in 5 (5%) patients, subcutaneous fat thickness was found in 2 (2%) patients at wrist dorsal view only, extensor tenosynovitis in 70 (70%) patients and flexor tenosynovitis 36 (36%) patients. **Conclusion:** Ultrasound is considered an effective tool for diagnosis of early undiagnosed hand and wrist pain and evaluation of several pathologic conditions of the hand and wrist.

### INTRODUCTION

Hand and wrist pain is considered one of major causes of disability in working populations and frequently caused by arthritis, both inflammatory and non-inflammatory, periarticular disorder, degenerative joint disease, and infections.<sup>1</sup>

Pain and dysfunction of the wrist or hand are a common symptom among different age groups and occupations which may accompanied by other medical problems that may affect the current problem.<sup>2</sup>

The hand has an important role in achieving satisfactory function in our daily life such as the ability to touch, feel sensation and grip objects. Hand pain is a strong parameter to determine hand function as well as age, history, manual occupation, hand strength, and neck or shoulder pain. An accurate and comprehensive assessment of hand pain is necessary to achieve an ultimate relief and functional status.<sup>3</sup>

Musculoskeletal Ultrasound (MSUS) is a non-invasive method that enables differentiation between different causes of pain of the wrist or hand and evaluation of several joints during initial stage of the disease and in mild symptoms. It can evaluate soft tissues include joint cartilage, synovium, joint capsule, tendons, ligaments, muscles, nerves, and adjacent bony cortex.<sup>4</sup>

US offers the opportunity to compare the anatomical findings with clinical assessment in 'real-time'. In the evaluation of patients with regional pain, the integration of the US information with the clinical data plays a major role in disease monitoring, assessment of damage and management.<sup>5</sup>

According to the European Society of Musculoskeletal Radiology (ESSR), sonography is the first-choice technique for wrist and hand evaluation. Current ultrasound systems allow for visualization of the small superficial structures of the wrist and hand with high resolution technique.<sup>6</sup>

US can find masses and fluid collections, help locate radiolucent foreign bodies, characterize traumatic or overuse tendon or ligament pathology, help evaluate compressive peripheral neuropathy and microvascular blood flow. Recently, US is preferred over plain film radiograph as diagnostic rheumatoid imaging, revealing subclinical inflammation, and predicting progression of joint damage.<sup>7</sup>

US has become an integral outcomes measure in documenting subclinical disease, and it allows accurate evaluation of soft tissues and bone profile. Early studies validated the utility of Doppler ultrasound in detecting subclinical synovitis in small joints.<sup>8</sup>

MSUS is more sensitive than conventional radiography in the detection of joint erosion, which can be usually visualized in RA, spondylarthritis (SpA), or crystal-related arthropathies, even in the early stage of the disease. Imaging the palmar and dorsal surfaces of the hand in both axial and longitudinal planes is recommended to show erosions, and osteophytes.<sup>9</sup>

The main advantage of hand and wrist MSUS is its widespread, minimal cost, the possibility to compare with the contralateral side, dynamic assessment of tendons and muscles, and good evaluation of superficial tissues with high resolution.<sup>10</sup> Our rationale was to assess the value of High-Resolution MSUS in diagnosis of early undiagnosed hand and wrist pain and their causes which help in accurate patient management and prompt recovery.

## **PATIENTS AND METHODS**

After the approval of our ethical committee and written informed consent from all participants, 100 patients with early bilateral hand pain enrolled in this study. A cross sectional study involved 100 patients with bilateral hand and wrist pain, recruited from Musculoskeletal Ultrasound Outpatient Clinics in Aswan University Hospital during the period from 1 January 2021 till 1 February 2022. After taking detailed history from each participant in our study, complete clinical examination was done.

### **Laboratory assessment:**

All investigations needed to reach final correct diagnosis were done to the patients according to history and clinical examination. For example:

- C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), rheumatoid factor (RF) and anti-citrullinated cyclic peptides antibodies (Anti-CCP) (in susceptible patients of rheumatoid arthritis).
- Uric acid and urine analysis (in susceptible patients of gouty arthritis).
- Thyroid-stimulating hormone (TSH), free and total thyroxine (T4) (in susceptible patients of hypothyroidism).
- Hemoglobin A1C (HbA1c) (in susceptible patients of diabetes mellitus). Etc.....
- X-ray hand for all patients in posteroanterior view (P-A).

### **Inclusion criteria:**

- Patients with early different types of hand pain (more than 6 weeks and not exceed 6 month).
- Visual analogue scale > 5.
- Bilateral hand pain.
- Age 18 years or older (exclude juvenile conditions).

### Exclusion criteria:

- Diagnosed cases (there is no need for ultrasound) .
- Age < 18 years.
- History of hand trauma, surgical intervention or any rheumatic disease.

Musculoskeletal ultrasound (MSUS) of wrists and hands was done with a 10–18 MHz linear scanner and middle class to high-end machine US device. All patients were assessed and examined by one medical staff. It was performed in transverse and longitudinal planes. Dorsal aspect of the wrist was examined transversely first for scanning of the extensor tendons. Longitudinal examination was done next to confirm the findings of the transverse examination and to identify effusion, synovial thickening, and ganglia. Volar aspect of the wrist was examined also in transverse and longitudinal position for scanning of flexor compartment and carpal tunnel contents respectively. Synovitis of the wrist was observed in dorsal and volar aspect. Each area of the hand was examined dynamically across a full range of transverse and longitudinal views. Standard scans for each joint include dorsal longitudinal scan, dorsal transverse scan, palmer longitudinal scan and palmar transverse scan were done.<sup>11</sup>

Pain assessment was done for all patients by using visual analogue scale (VAS).

Final diagnosis was done by ultrasound finding, clinical and laboratory correlations.

### Statistical analysis:

The statistical analysis was done via statistical package for social sciences (SPSS) version 22 (SPSS Inc, Chicago, USA). For qualitative data, frequency and percent distributions was calculated.

### RESULTS

This study involved 100 patients with bilateral hand pain, with mean age 41.27 years range from 19 - 66 years old. The majority (76%) of the patients were females.

The pattern of pain was inflammatory in 54(54%) patients, mechanical in 44(44%) & mixed in 2(2%) patients.

X-ray hand (P-A) view was done for all patients. All investigations needed to reach final diagnosis were done to the patients according to history and clinical examination.

By ultrasound examination on both hands:

We found that Synovitis was found in 69 (69%) patients. At dorsal view, synovitis was detected in 69(69%) patients; 38 (38%) patients at wrist, 66 (66%) patients at metacarpophalangeal joints (MCPs), 31 (31%) patients at proximal interphalangeal joints (PIPs), 1 (1%) patient at distal interphalangeal joints (DIPs), 7 (7%) patients at carpometacarpal joints (CMC) as shown in Table 1. However, at volar view, synovitis was detected in 33(33%) patients; 17(17%) patients at wrist, 29(29%) patients at MCPs, 7(7%) patients at PIPs, 6(6%) patients at CMC as shown in table 1. DIPs had no synovitis affection in this view.

Erosions were found in 28 (28%) patients. At dorsal view, they were found in 28(28%) patients, 11(11%) patients at wrist, 19(19%) patients at MCPs, 9 (9%) patients at PIPs, 2 (2%) patients at CMC as shown in Table 2. However, at volar view, they are found in 11(11%) patients, 2(2%) patients at wrist, 9(9%) patients at MCPs, 4 (4%) patients at PIPs. No erosions detected at PIPs joints at dorsal or volar in our study as shown in Table 1.

Double contour sign was found in 6 (6%) patients. At dorsal view, it was found in 6 (6%) patients, 4 (4%) patients at MCPs, 6 (6%) patients at PIPs, 4 (4%) patients at CMC. No double contour sign detected in volar view as shown in Table 1.

Osteophytes were found in 33 (33%) patients. At dorsal view, they are found in 31 (31%) patients, 4 (4%) patients at wrist, 21 (21%) patients at MCPs, 21(21.43%) at PIPs, 14(14%) patients at DIPs, 10(10%) patients at CMC as shown in Table 2. However, at volar view, they are found in 13 (13%)

patients, 3 (3%) patients at wrist, 7 (7%) patients at MCPs, 6(6%) at PIPs, 2(2%) patients at DIPs, 4(4%) patients at CMC as shown in Table 1.

Synovial hypertrophy was found in 5(5%) patients. At dorsal view, it was found in 5(5%) patients, 5(5%) patients at wrist, 1(1%) patient at MCPs. No synovial hypertrophy was found at volar view as shown in Table 1.

Subcutaneous fat thickness was found in 2 (2%) patients at wrist dorsal view only as shown in Table 1. Extensor tenosynovitis was found in 70 (70%) patients. Flexor tenosynovitis was found in 36 (36%) patients as shown in Table 2.

Final diagnosis was done by ultrasound finding, clinical and laboratory correlations.

Different diagnoses were done at the end of our study as discussed in Table 3.

Four of them showed no abnormal ultrasound finding, they were hypovitaminosis (6 patients), hyperparathyroidism (4 patients), autoimmune thyroiditis (2 patients) and osteoporosis (2 patients).

34(34%) patients were diagnosed RA, 19(19%) patients were diagnosed mechanical hand, 10(10%) patients were diagnosed gouty arthritis, 9(9%) patients were diagnosed reactive arthritis, 8(8%) patients were diagnosed diabetic arthropathy, 4(4%) patients were diagnosed Undifferentiated seronegative arthritis, 2(2%) patients were diagnosed panniculitis.

## DISCUSSION

Ultrasound of wrist and hand revealed a wide spectrum of finding in our study group, four of them showed no abnormal ultrasound finding, and they were hypovitaminosis (6 patients), hyperparathyroidism (4 patients), autoimmune thyroiditis (2 patients) and osteoporosis (2 patients). On the other hand, 34 of all studied cases showed Rheumatoid arthritis, Gouty arthritis (10 patients), Reactive arthritis (9 patients), Mechanical hand (19 patients), Diabetic arthropathy (8 patients), Undifferentiated seronegative arthritis (4 patients) and Panniculitis (2 patients).

The study of **Bhadu et al.**<sup>12</sup> reported that, regarding global ultrasound findings, abnormal ultrasound findings were found among 41 of 47 gout patients (87.2%) and eight of 50 controls (16%). MSUS abnormalities were with a sensitivity and specificity of 84.6% and 83.3%, respectively.

Also, **El-Deek et al.**<sup>13</sup> noted that, all patients have tenosynovitis, 8 (80%) patients with trigger finger, 10 (83.3%) patients with complete tendon tear and misdiagnosed 2 patients (16.7%) as a tenosynovitis which were diagnosed by MRI as partial tendon tear. Also, MSUS detected simple ganglions in all patients and confirmed by follow-up. It identified all patients with solid lesion and foreign body.

By ultrasound examination on both hands by grey scale ultrasound (GSUS), at dorsal view Synovitis was detected in 69(69%) patients. While at volar view Synovitis was detected in 33(33%) patients, DIPs had no synovitis affection in this view. Erosions were found at dorsal view in 28(28%) patients and at volar view they are found in 11(11%) patients. Osteophytes were found in only at dorsal view, Synovial hypertrophy was found in at dorsal view only, Extensor tenosynovitis was detected in 32 patients and Flexor tenosynovitis was detected in 19 patients. In all previous detecting dorsal view was more sensitive than volar view.

**Vlad et al.**<sup>14</sup> showed that on examination of 16 finger joints for each of the 42 patients included in the study (a total of 672 joints for each side). The highest prevalence of positive synovitis (>1 semi quantitatively) has been found in carpal joints (91%). For the rest of the joints, we found a variable prevalence of positive synovitis from the highest (88.1%) in MCP2 volar side to the lowest (35,7%) in PIP5 volar side. We discovered a systematic higher prevalence of GSUS positivity on the volar vs. dorsal side.

**Ohrndorf et al.**<sup>15</sup> showed that, regarding baseline US findings, the DAS28 was 4.5, the synovitis score in GSUS was 26.3, the synovitis score in power doppler ultrasound (PDUS) was 10.6, the tenosynovitis score in GSUS was 2.4, the tenosynovitis score in PDUS was 2.1 and the erosion score was 21.5 (while the number of erosions was 8.0).

**Wakefield et al.**<sup>16</sup> reported that, Sonography detected 127 definite erosions in 56 of 100 RA patients, compared with radiographic detection of 32 erosions (26 [81%] of which coincided with sonographic erosions) in 17 of 100 patients ( $P < 0.0001$ ). In early disease, sonography detected 6.5-fold more erosions than did radiography, in 7.5-fold the number of patients.

In a previous study by **Ceponis et al.**<sup>17</sup>, there were two examples of low-grade synovial hypertrophy in at least one image of one wrist and one second MCP joint; one of the participants showed a grade 1 PD signal that might have been caused by a penetrating cortical blood vessel rather than a synovial signal. In both the RA and healthy volunteer groups, sonographic evaluation of the PIP joints indicated a significant incidence of osteophytosis/degenerative alterations. Significant osteoarthritis of the PIP joints was seen as a possible source of interference with clinical joint evaluation, especially joint tenderness assessment. As a result, PIP joints were omitted from the clinical–sonographic agreement analysis.

Also, in the current study 10 patients were diagnosed gouty arthritis, Synovitis was detected in dorsal view more than volar view, MCPs were the most affected joints in both dorsal and volar view. Erosions and synovial hypertrophy weren't found in this group. Osteophytes were found in 8(80%) patients. Double contour sign was present at dorsal view only and Flexor tenosynovitis wasn't detected in this group.

**Ventura-Ríos et al.**<sup>18</sup> study noted that, the prevalence of double-contour sign was 44 % (35 patients) in gout the specificity of tophi vs PD was 86.76%, and the hyperechoic aggregates vs PD was 85.11%.

**Thiele and Schlesinger.**<sup>19</sup> reported that Ultrasound findings seen in the joints of their study patients were the following: a hyperechoic, irregular band over the superficial margin of the articular cartilage of the metatarsal heads, metacarpal heads, femoral condyles, and humeral head was seen in 34 (92%) of the gouty joints and in none of the controls ( $P < 0.001$ , Fisher's exact test). Hypoechoic to hyperechoic, inhomogeneous material often surrounded by a small anechoic rim, representing tophaceous material, was seen in all gouty MCP joints ( $n = 4$ ) and in none of the controls ( $P < 0.001$ , Fisher's exact test).

On the other hand, there were 9 patients diagnosed reactive arthritis, synovitis was detected in dorsal view more than volar view, MCPs were the most affected joints. Extensor tenosynovitis was detected in 7 (77.78%) patients and Flexor tenosynovitis was present in 3 (33.33%) patients.

In the same line, **Danssaer et al.**<sup>20</sup> study reported that a 37-year-old female arrived for assessment of severe right-hand pain, ultrasonography of the right hand and wrist revealed inflammation around the right hand's flexor and extensor tendons. This patient had reactive arthritis and was prescribed ultram for pain management, occupational therapy, and was urged to return if the pain did not relieved.

## CONCLUSION

Ultrasound is considered an effective tool for diagnosis of early undiagnosed hand and wrist pain and evaluation of several pathologic conditions of the hand and wrist. knowledge of the potential pitfalls is important to avoid misdiagnosis and achieve high diagnostic accuracy.

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**Table 1: Shows U/S finding distribution in dorsal and volar views for whole study group.**

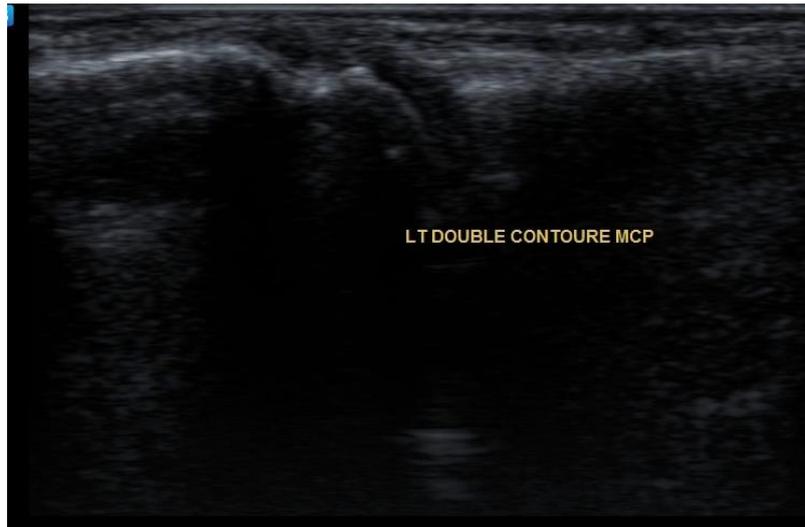
	Dorsal View	Total	Wrist	MCPs	PIPs	DIPs	CMC
Dorsal View	Synovitis	69 (69%)	38 (38%)	66 (66%)	31 (31%)	1 (1%)	7 (7%)
	Erosions	28 (28%)	11 (11%)	19 (19%)	9 (9%)	0 (0%)	2 (2%)
	Double contour	6 (6%)	0 (0%)	4 (4%)	6 (6%)	0 (0%)	4 (4%)
	Osteophytes	31 (31%)	4 (4%)	21 (21%)	21 (21.43%)	14 (14%)	10 (10%)
	synovial hypertrophy	5 (5%)	5 (5%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)
	Subcutaneous fat	2 (2%)	2 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Volar View	Synovitis	33 (33%)	17 (17%)	29 (29%)	7 (7%)	0 (0%)	6 (6%)
	Erosions	11 (11%)	2 (2%)	9 (9%)	4 (4%)	0 (0%)	0 (0%)
	Osteophytes	13 (13%)	3 (3%)	7 (7%)	6 (6%)	2 (2%)	4 (4%)

**Table 2: Shows Extensor tenosynovitis and Flexor tenosynovitis findings for whole study group.**

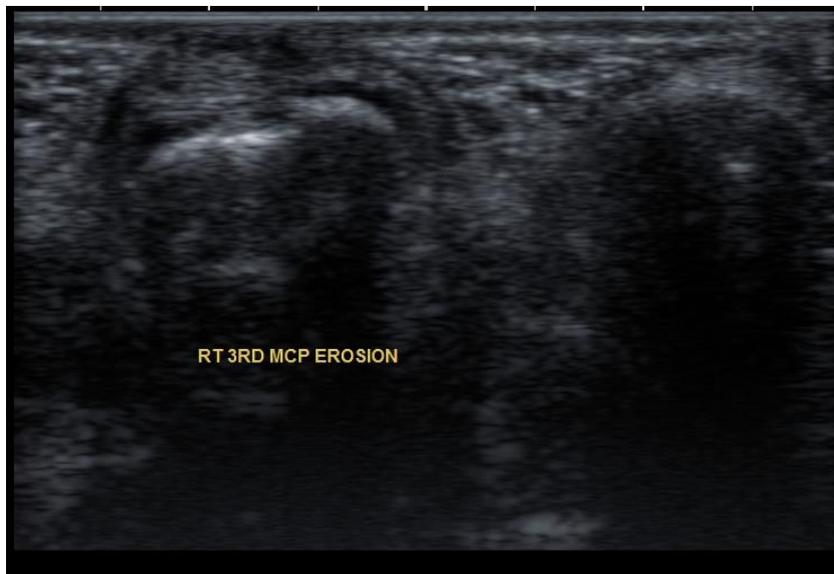
		N (%)
Extensor tenosynovitis	Negative	30 (30.0%)
	Positive	70 (70.0%)
Flexor tenosynovitis	Negative	64 (64.0%)
	Positive	36 (36.0%)

**Table 3: Relation between diagnosis and finding in each diagnosis.**

	Synovitis	Erosions	Double contour	Osteophyte	synovial hypertrophy	Subcutaneous fat	Extensor tendosynovitis	Flexor tendosynovitis
	N (Row %)	N (Row %)	N (Row %)	N (Row %)	N (Row %)	N (Row %)	N (Row %)	N (Row %)
Rheumatoid arthritis (N= 34)	34 (100.0%)	24 (70.59%)	0 (0.0%)	2 (5.88%)	1 (2.94%)	0 (0.0%)	32 (94.12%)	19 (55.88%)
Mechanical hand (N= 19)	12 (63.16%)	0 (0.0%)	0 (0.0%)	13 (68.42%)	0 (0.0%)	0 (0.0%)	17 (89.47%)	10 (52.63%)
Gouty arthritis (N= 10)	8 (80.0%)	0 (0.0%)	6 (60.0%)	8 (80.0%)	0 (0.0%)	0 (0.0%)	6 (60.0%)	0 (0.0%)
Reactive arthritis (N= 9)	9 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (77.78%)	3 (33.33%)
Diabetic arthropathy (N= 8)	2 (25.0%)	0 (0.0%)	0 (0.0%)	8 (100.0%)	4 (50.0%)	0 (0.0%)	6 (75%)	2 (25%)
Undifferentiated seronegative arthritis (N= 4)	4 (100.0%)	4 (100.0%)	0 (0.0%)	2 (50.0%)	0 (0.0%)	0 (0.0%)	2 (50.0%)	2 (50.0%)
Panniculitis (N= 2)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (100.0%)	0 (0.0%)	0 (0.0%)



**Figure 1: a case of gouty arthritis.**



**Figure 2: a case of rheumatoid arthritis.**



**Figure 3: a case of mechanical hand.**