Original Article

# Ability of the European League Against Rheumatism-Outcomes Measures in Rheumatology combined scoring system for grading dorsal joint space synovitis to accurately evaluate ultrasound-detected hand synovitis

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**Background:** The European League Against Rheumatism-Outcomes Measures in Rheumatology (EULAR-OMERACT) recommend only scanning dorsal spaces for scoring ultrasound-detected hand synovitis. This study evaluated the efficiency of the combined scoring system only depending on dorsal joint spaces synovitis in diagnosing and evaluating ultrasound-detected hand synovitis.

**Methods:** The data of 56 patients who underwent hand joint ultrasonography exams in the Ultrasound Department of West China Hospital, Sichuan University were prospectively collected. The participants formed a random series. The images of each patient included gray-scale (GS) and power Doppler (PD) images of bilateral first to fifth metacarpophalangeal joints (MCP) and the thumb and second to fifth proximal interphalangeal joints (IP). The synovial thickness was measured quantitatively in GS images, and the synovial GS scores in the dorsal joint spaces and PD scores in the dorsal and volar joint spaces were calculated according to the combined EULAR-OMERACT scoring system.

**Results:** The detection rate of synovitis in the first to fifth MCP, thumb and second to fifth proximal IP synovitis were 41.4% (232/560) and 33.9% (190/560), respectively. The sensitivity of only inspecting the dorsal joint spaces with GS ultrasound was 79.3% for MCP and 52.6% for the thumb and second to fifth proximal IPs. The PD scores were higher in the dorsal joint spaces than in the volar joint spaces (P value <0.001). The combined scores were higher than either the GS or PD scores alone in the dorsal joint spaces (P value of the combined scores *vs.* GS scores =0.001; P value of the combined scores *vs.* PD scores <0.001).

**Conclusions:** Adopting the EULAR-OMERACT combined scoring standard is recommended to evaluate ultrasound-detected hand synovitis, as determined by the highest value of the GS scores or the PD scores. More specifically, PD scores can mainly be used to appraise the dorsal joint spaces. However, GS scores should be used to evaluate both the dorsal joint spaces and the volar joint spaces.

**Keywords:** Hand joint synovitis; gray-scale ultrasound (GS ultrasound); power Doppler ultrasound (PD ultrasound); European League Against Rheumatism-Outcomes Measures in Rheumatology combined scoring system (EULAR-OMERACT combined scoring system)

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## Introduction

Synovitis is one of the most common clinical manifestations of various rheumatic diseases. Synovitis is frequently associated with rheumatoid arthritis (RA), osteoarthritis (OA), and systemic lupus erythematosus (1-3). Effective and early detection of synovitis is not only advantageous for predicting the development of early rheumatic diseases but also favorable for the diagnosis and clinical management of rheumatic diseases. In addition, prolonged delay in diagnosing synovitis or misdiagnosis can worsen patient outcomes (4). Therefore, swift diagnosis, evaluation, and regular monitoring of synovitis are critical to expediting the effective management and treatment of this disease.

The diagnostic value of ultrasound for synovitis has been widely recognized. In 2010, the American College of Rheumatology (ACR) classification criteria included ultrasound-detected synovitis as a diagnostic index for RA (1). The ultrasonographic manifestation of synovitis is regarded as synovial hypertrophy (SH), which can be accompanied by joint effusion. SH is characterized by abnormal hypoechogenicity in the joint cavity. It is not displaceable and difficult to compress, and blood flow signals can be detected. Joint effusion manifests as a anechoic area within the joint cavity in ultrasound imaging, which can be compressed and displaced, and blood flow signal cannot be detected. Simple joint effusion means that only joint effusion can be detected without SH. Simple joint effusion may appear in healthy individuals, so it is not an ultrasonic sign of synovitis (5,6). Since ultrasound cannot penetrate the bone cortex, it cannot display synovitis of the whole joint cavity in a single section. It is thus necessary to scan the whole joint in multiple sections to accurately evaluate hand synovitis. The hand joints include 14 joints: the first to fifth metacarpophalangeal joints (MCP), the thumb interphalangeal joint (IP), the second to fifth proximal IPs, and the second to fifth distal IPs. In the ultrasonic examination of hand synovitis, it is often necessary to conduct a complete examination of the above-mentioned joints one by one (7,8). However, a comprehensive scanning of all hand joints and sections is time and labor consuming. As a result, physicians have begun to explore the possibility of reducing the number of inspected joints and sections without sacrificing diagnostic sensitivity, specificity, or accuracy. The European League Against Rheumatism-Outcomes Measures in Rheumatology (EULAR-OMERACT) combined scoring system of ultrasound-detected hand synovitis recommends using the dorsal median sections of some MCPs and IPs to represent the situation of the whole hand (9-13). However, only a few studies have examined whether these dorsal sections could accurately represent the actual situations of ultrasound-detected hand synovitis. The purpose of our study was thus to determine whether hand synovitis manifests differently under ultrasonography in the dorsal and volar spaces of the same hand joints and to identify which spaces can best represent the actual situation of ultrasound-detected hand synovitis. Our findings may bear considerable significance for the accurate and simplified evaluation of ultrasound-detected hand synovitis. We present this article in accordance with the STARD reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-23-1211/rc).

## Methods

### *Research participants*

In this study, we retrospectively analyzed 59 patients who had undergone ultrasound exams at the Ultrasound Department of West China Hospital, Sichuan University from May 2022 to December 2022. The inclusion criterion for patients was hand synovitis detected by ultrasound. Meanwhile, the exclusion criteria were (I) simple hand joint effusion and (II) obvious hand joint deformity which could affect ultrasonic examination. After applying the exclusion criteria, this study collected the data of 56 patients with ultrasound-detected hand synovitis (as shown in *Figure 1*). These data included age, gender, height, weight, body mass index (BMI), medical history, and other core information.

### *Instrument setting and inspection method*

A Phillips iU22 ultrasound system (Bothell, WA, USA) with an L12-5 linear array probe under the general musculoskeletal condition was adopted for this study. The depth was adjusted to 2.5–4 cm as needed, and the focus was adjusted to the level of the hand joint cavity. If a color artifact appeared, the power Doppler (PD) gain was

 

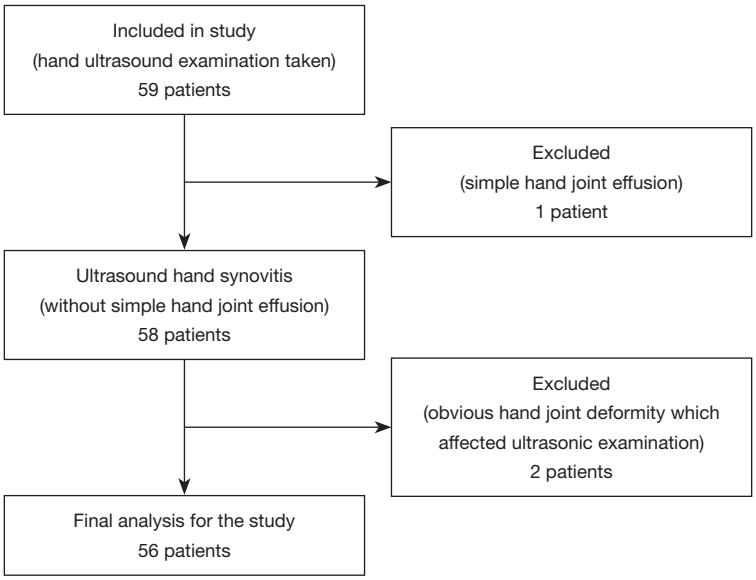


**Figure 1** Diagram illustrating the process of case selection.

gradually reduced until the color artifact disappeared.

For the inspection method, static images representing synovitis in the first to fifth MCPs, thumb, and second to fifth proximal IPs (hereinafter referred to as IPs) were collected. Images were obtained using the preliminary EULAR-OMERACT definition for synovitis which included both gray-scale (GS) (SH and effusion) and PD findings. Images were acquired according to the EULAR recommendations, with a longitudinal scan obtained under both a dorsal and volar view (12,14).

### *Image analysis*

The measurement on GS images of synovial thickness was performed perpendicularly to the bone at the point of the greatest thickness of the hypoechoic area (*Figure 2*). The thickness was carefully measured three times on each section, and the average value was calculated. According to the EULAR-OMERACT scoring system (13), the synovial GS scores and PD scores were scored on a 0–3 scale. The GS scoring system was as follows: grade 0, no SH independent of the presence of effusion; grade I, minimal hypoechoic SH up to the level of the horizontal line connecting bone surfaces; grade II, moderate hypoechoic SH extending beyond joint line but with the upper surface concave (curved downward) or the upper surface flat; and grade III, severe hypoechoic SH with or without effusion extending beyond the joint line with the upper surface convex (curved upward). The PD scoring system was as follows: grade 0, no Doppler signal; grade I, up to three single Doppler spots or up to one confluent spot and two single spots or up to two confluent spots; grade II, > grade I but ≤50% Doppler signals in the total GS background; and grade III, > grade II (>50% of the total GS background). GS scoring was conducted in the dorsal median sections, while PD scoring was conducted in the dorsal and volar median sections. The combined scores were calculated based on the above-mentioned parameters. The combined scores of dorsal joint spaces were determined by the highest value of the GS scores or the PD scores of the dorsal median sections. The combined scores of multijoint spaces (dorsal joint spaces and volar joint spaces) were determined by the highest value among the GS scores of the dorsal median sections or the PD scores of the dorsal and volar median sections.

Intraobserver and interobserver reliability of the GS and PD scores was examined in evaluations performed by two sonographers, Y.Y. (10 years of experience in musculoskeletal ultrasound) and T.T. (1 year of experience in musculoskeletal ultrasound), who analyzed 40 randomly selected images and independently scored the GS and PD grades. Two weeks later, the process was repeated with a rerandomized order. The two sonographers were blinded to the patients' clinical details and each other's scoring results.

 

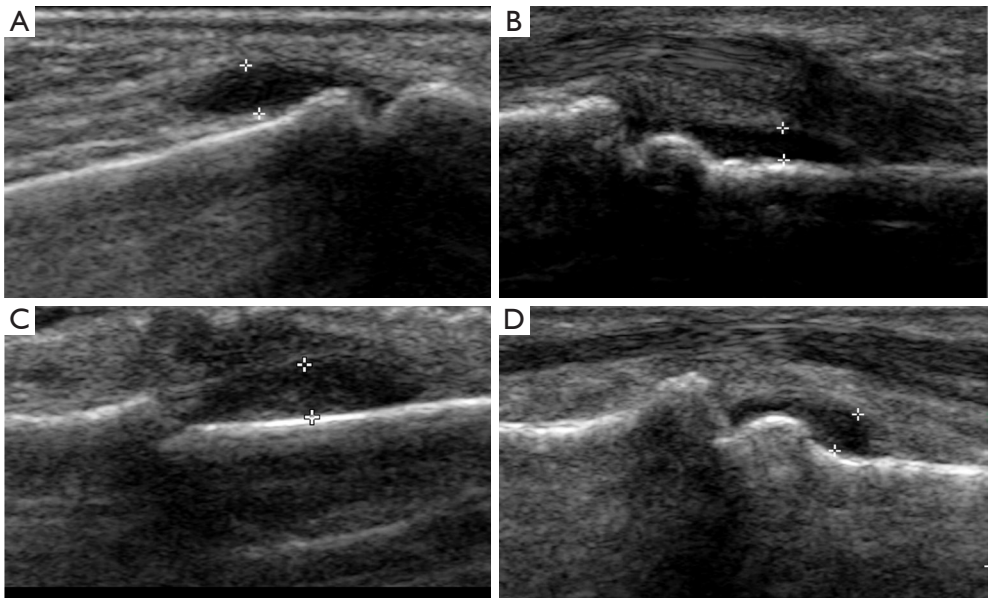


**Figure 2** The measurement standard of the thickness of synovium. (A) MCPs the in dorsal joint spaces. (B) MCPs in the volar joint spaces. (C) IPs in the dorsal joint spaces. (D) IPs in the volar joint spaces. MCP, metacarpophalangeal joint; IP, interphalangeal joint.

### *Statistical analysis*

Data were processed using SPSS 26.0 software (IBM Corp., Chicago, IL, USA). The paired-sample *t*-test was used to compare the paired samples in comparison of synovial thickness between dorsal and volar joint spaces of hand synovitis under different EULAR-OMERACT GS scores. The Wilcoxon signed rank test was used for the comparison of grade data (comparison of PD scores between dorsal and volar joint spaces; comparison of combined scores, GS scores, and PD scores of dorsal joint spaces; and comparison of combined scores between dorsal joint spaces and multijoint spaces). All P values were calculated with two-sided tests, and the difference was considered statistically significant when $P<0.05$.

Intraobserver reliability was assessed by calculating the intraclass correlation coefficient (ICC; two-way mixed effects). An ICC <0.40 was considered poor, 0.40–0.74 moderate, and ≥0.75 excellent. Interobserver reliability was evaluated with the Kendall W coefficient, with a value <0.40 being considered poor, 0.40–0.50 moderate, 0.51–0.70 good, and 0.71–1.00 excellent.

### *Ethical statement*

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Ethics Committee of West China Hospital, Sichuan University [approval No. 2022(1691)]. Informed consent was obtained from all participants or their legal guardians.

## Results

### *General information*

A total of 56 patients with ultrasound-detected hand synovitis were included in this study. The demographics characteristics of study population are presented in *Table 1*. Among the 56 cases of hand synovitis, 27 cases were RA, 4 were connective tissue disease, 1 was OA, 1 was dermatomyositis, 1 was adult Still disease, 1 was infectious arthritis, 1 was undifferentiated arthritis, 1 was pyrophosphate arthritis, and the remaining 19 cases were arthralgia of unconfirmed etiology. The course of disease was 0.1–30 years, and the median course of disease was 3.0 (interquartile range 5.7) years.

### *Intraobserver reliability and interobserver reliability of GS scores and PD scores*

The mean values of ICCs and Kendall W coefficients are shown in *Table 2*. The ICCs for GS scores and PD scores were 0.708 and 0.953, respectively. The Kendall W

 

coefficients were 0.840 for GS scores and 0.942 for PD scores. Both the ICCs and Kendall W coefficients were not 0 and had statistical significance for GS scores and PD scores (P<0.05).

### *Detection and distribution of hand synovitis*

In the 560 MCPs in 56 patients, SH detected in either the dorsal joint spaces or volar joint spaces was defined as MCP synovitis. SH was detected in 232 MCPs. The detection rate of MCP synovitis was 41.4% (232/560). MCP synovitis was bilaterally symmetric, with the index fingers, middle fingers, and little fingers being the most compromised structures. The details are shown in *Figure 3*. The number of patients with only involvement of the dorsal joint spaces, volar joint spaces, and both the dorsal and volar joint spaces was 40 (17.2%), 48 (20.7%), and 144 (62.1%), respectively. The sensitivity of only inspecting the dorsal joint spaces was 79.3%, while that of only inspecting the volar joint spaces was 82.8%.

**Table 1** Demographic characteristics of the study population

| Characteristic | Value |
|---|---|
| Sample size (n) | 56 |
| Gender (n) | |
| Male | 13 |
| Female | 43 |
| Age (years) | 13–82 (51±14) |
| Height (cm) | 120–175; 158.5 (7.0) |
| Weight (kg) | 40–92; 55.5 (10.0) |
| BMI (kg/m$^2$) | 15.6–34.7 (22.8±3.8) |

Categorical data (sample size, gender) are expressed as the number; normally distributed data (age, BMI) are expressed as the range (mean ± standard deviation); nonnormally distributed data (height, weight) are expressed as the range; median (interquartile range). BMI, body mass index.

Of the 560 IPs in 56 patients with hand synovitis, 190 were diagnosed with SH of different degrees. The detection rate of IP synovitis was 33.9% (190/560). IP synovitis was bilateral and symmetrical, with the index fingers, middle fingers, and ring fingers being the most commonly diagnosed (*Figure 3*). Among these lesions, 11 (11/190, 5.8%) were found only in the dorsal joint spaces, 90 (90/190, 47.4%) were found only in the volar joint spaces, and 89 (89/190, 46.8%) were found in both the dorsal and volar joint spaces. The sensitivity of only inspecting the dorsal joint spaces and volar joint spaces was 52.6% and 94.2%, respectively.

### *Comparison of synovial thickness between different joint spaces of hand synovitis under different EULAR-OMERACT GS scores*

The EULAR was only used to score ultrasound-detected hand synovitis in the dorsal joint spaces, and there was no standard scoring for the volar joint spaces. The GS scores could be only conducted in the dorsal joint spaces. This meant that the cases of ultrasound-detected hand synovitis only detected in volar joint spaces would be classified as grade 0. The results of 232 cases of MCP synovitis under different EULAR-OMERACT GS scores are summarized in *Table 3*. For grade 0, 48 cases of MCP synovitis were detected only in the volar joint spaces. The difference of synovial thickness of MCP synovitis between volar joint spaces and dorsal joint spaces was statistically significant. In grades I and II, there was no significant difference in synovial thickness between the dorsal and volar joint spaces. In grade III, the thickness of synovium in the dorsal joint spaces was higher than that in the volar sides, and the difference was statistically significant.

The results of 190 cases of IP synovitis under different EULAR-OMERACT GS scores are summarized in *Table 3*. In grade 0, 90 cases of IP synovitis were detected only in the volar joint spaces. The difference of synovial thickness of IP synovitis between volar joint spaces and dorsal joint spaces

**Table 2** Intraobserver and interobserver reliability for the scoring of synovitis in hand joints on static images

| Score | Intraobserver | | | Interobserver | |
|---|---|---|---|---|---|
| | ICC | 95% CI | P value | Kendall W | P value |
| SH score | 0.708 | 0.513–0.834 | <0.001*** | 0.840 | 0.005** |
| PD score | 0.953 | 0.913–0.975 | <0.001*** | 0.942 | 0.001*** |

**, P≤0.01; ***, P≤0.001. ICC, intraclass correlation coefficient; CI, confidence interval; SH, synovial hypertrophy; PD, power Doppler.

 

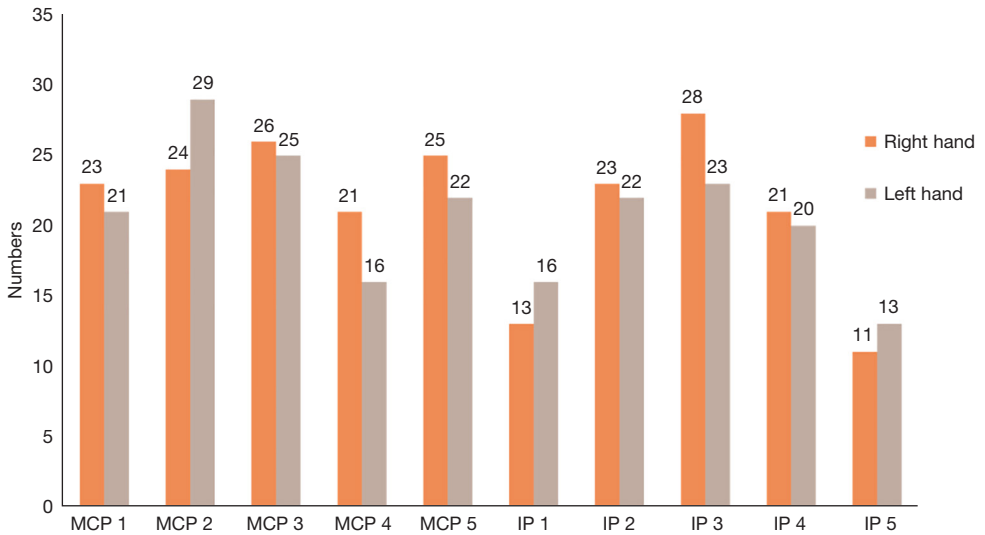


**Figure 3** The detection and distribution of ultrasound-detected hand synovitis. MCP, metacarpophalangeal joint; IP, interphalangeal joint.

**Table 3** Comparison of synovial thickness between different joint spaces under different EULAR-OMERACT GS scores

| GS score | SH thickness of MCPs (mm) | | | | SH thickness of IPs (mm) | | | |
|---|---|---|---|---|---|---|---|---|
| | Cases, n | Dorsal | Volar | P value | Cases, n | Dorsal | Volar | P value |
| Grade 0 | 48 | 0.00±0.00 | 2.39±0.99 | <0.001*** | 90 | 0.00±0.00 | 1.56±0.49 | <0.001*** |
| Grade I | 59 | 1.42±0.31 | 1.42±1.17 | 0.610 | 53 | 1.11±0.25 | 1.42±0.68 | 0.002** |
| Grade II | 55 | 2.20±0.35 | 1.98±1.30 | 0.205 | 35 | 2.06±0.36 | 1.67±1.02 | 0.040* |
| Grade III | 70 | 3.93±1.01 | 2.64±1.59 | <0.001*** | 12 | 3.21±0.52 | 2.59±0.65 | 0.001*** |

Data are expressed as the mean ± standard deviation. *, P≤0.05; **, P≤0.01; ***, P≤0.001. EULAR-OMERACT, European League Against Rheumatism-Outcomes Measures in Rheumatology; GS, gray scale; SH, synovial hypertrophy; MCP, metacarpophalangeal joint; IP, interphalangeal joint.

was statistically significant. In grade I, the thickness of the synovium in the volar joint spaces was higher than that in the dorsal joint spaces, and the difference was statistically significant. In grades II and III, the thickness of synovium in the dorsal joint spaces was higher than that in the volar sides, and the difference was statistically significant.

### *Comparison of PD scores between the dorsal and volar joint spaces of hand synovitis*

When the PD scores of the dorsal and volar joint spaces of the same hand joint were inconsistent, whichever was higher was considered to be the final PD score. Of the 232 cases of MCP synovitis, 109 (109/232, 47.0%) did not manifest a blood flow signal, and 123 (123/232, 53.0%) did manifest a blood flow signal, of which 87 (87/123, 70.7%) were detected only in the dorsal joint spaces, 11 (11/123, 8.9%) only in the volar joint spaces, and 25 (25/123, 20.3%) in both the dorsal and volar joint spaces. The blood flow signal in the dorsal joint spaces was more sensitive than that in the volar sides.

Of the 190 cases of IP synovitis, 148 did not display blood flow signals (148/190, 63.8%), and 42 (42/190, 42.2%) did display blood flow signals, of which 31 (31/42, 73.8%) were detected only in the dorsal joint spaces, 5 (5/42, 11.9%) only in the volar sides, and 6 (6/42, 14.3%) in both the dorsal and volar spaces. Both the PD scores of dorsal joint spaces and the final PD scores were higher than the PD scores of the volar joint spaces. Moreover, the difference between the PD scores of the dorsal joint spaces and the final PD scores was not statistically significant. The details are shown in *Table 4*.

 

**Table 4** Comparison of PD scores between the dorsal and volar joint spaces

| PD score | MCPs, n (%) | | | | IPs, n (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | Dorsal | Volar | Final | P value | Dorsal | Volar | Final | P value |
| Grade 0 | 120 (51.7) | 196 (84.5) | 109 (47.0) | <0.001†; <0.001‡; <0.001§ | 153 (80.5) | 179 (94.2) | 148 (77.9) | <0.001†; <0.001‡; 0.034§ |
| Grade I | 45 (19.4) | 20 (8.6) | 50 (21.6) | | 12 (6.3) | 9 (4.7) | 16 (8.4) | |
| Grade II | 54 (23.3) | 12 (5.2) | 57 (24.6) | | 14 (7.4) | 2 (1.1) | 15 (7.9) | |
| Grade III | 13 (5.6) | 4 (1.7) | 16 (6.9) | | 11 (5.8) | 0 | 11 (5.8) | |

The corrected P value was used here, with P<0.05/3=0.017, which indicates that there was a statistical difference between the two groups. †, dorsal joint spaces *vs.* volar joint spaces; ‡, volar joint spaces *vs.* final; §, dorsal joint spaces *vs.* final. PD, power Doppler; MCP, metacarpophalangeal joint; IP, interphalangeal joint.

**Table 5** Comparison of combined scores, GS scores, and PD scores of the dorsal joint spaces

| Score | MCPs, n (%) | | | | IPs, n (%) | | | |
|---|---|---|---|---|---|---|---|---|
| | Combined | GS | PD | P value | Combined | GS | PD | P value |
| Grade 0 | 48 (20.7) | 48 (20.7) | 120 (51.7) | 0.001†; <0.001‡; <0.001§ | 90 (47.4) | 90 (47.4) | 153 (80.5) | 0.001†; <0.001‡; <0.001§ |
| Grade I | 51 (22.0) | 59 (25.4) | 45 (19.4) | | 46 (24.2) | 53 (27.9) | 12 (6.3) | |
| Grade II | 59 (25.4) | 55 (23.7) | 54 (23.3) | | 33 (17.4) | 35 (18.4) | 14 (7.4) | |
| Grade III | 74 (31.9) | 70 (30.2) | 13 (5.6) | | 21 (11.1) | 12 (6.3) | 11 (5.8) | |

The corrected P value is used here, with P<0.05/3=0.017, which indicates that there was a statistical difference between the two groups; †, combined scores *vs.* GS scores; ‡, GS scores *vs.* PD scores; §, combined scores *vs.* PD scores. GS, gray scale; PD, power Doppler; MCP, metacarpophalangeal joint; IP, interphalangeal joint.

### *Comparison of the combined scores, GS scores, and PD scores of the dorsal joint spaces*

Whichever of the GS score or the PD score for the dorsal joint space was higher was taken as the combined score of the dorsal joint space. The results of combined scores of the dorsal joint spaces of 232 cases of MCP synovitis were as follows: grade 0, 48 (48/232, 20.7%); grade I, 51 (51/232, 22.0%); grade II, 59 (59/323, 25.4%); and grade III, 74 (74/232, 31.9%). The results of the combined scores of 190 cases of IP with SH were as follows: grade 0, 90 (90/190, 47.4%); grade I, 46 (46/190, 24.2%); grade II, 33 (33/190, 17.4%); and grade III, 21 (21/190, 11.1%). There was a significant difference in the combined scores, the GS scores, and the PD scores of the dorsal joint spaces of MCP and IP synovitis. Further pairwise comparison between the two groups showed that the difference was statistically significant (*Table 5*).

### *Comparison of combined scores between dorsal joint spaces and multijoint spaces of hand synovitis*

Whichever of the GS score of the dorsal joint space or the PD score of the dorsal and volar joint spaces was highest was taken as the EULAR-OMERACT combined score of the multijoint spaces in 232 cases of MCP synovitis and 190 cases of IP synovitis. *Table 6* shows the results for the combined scores of the dorsal joint spaces and multijoint spaces of ultrasound-detected hand synovitis and their comparison. The combined score of the multijoint spaces was better than that of dorsal joint spaces, which rated some grade 0 and I to grade I and II, but did not affect the score of grade III.

## Discussion

### *Detection and distribution of hand joint synovitis*

MCP and IP synovitis are bilaterally and symmetrically in ultrasound-detected hand synovitis. In this study, MCP synovitis was common in the index finger, middle finger and little finger, while IP synovitis was common in the index finger, middle finger, and ring finger. Ceponis *et al.* (15) found that RA was more likely to involve the index finger and middle finger of MCP. Vlad *et al.* (16) found that the index finger was the most vulnerable among the

 

**Table 6** Comparison of combined scores between the dorsal joint spaces and multijoint spaces of ultrasound-detected hand synovitis

| Group | Combined scores of MCPs, n (%) | | | Combined scores of IPs, n (%) | | |
|---|---|---|---|---|---|---|
| | Dorsal joint spaces | Multijoint spaces | P value | Dorsal joint spaces | Multijoint spaces | P value |
| Grade 0 | 48 (20.7) | 42 (18.1) | 0.014* | 90 (47.4) | 87 (45.8) | 0.046* |
| Grade I | 51 (22.0) | 54 (23.3) | | 46 (24.2) | 48 (25.3) | |
| Grade II | 59 (25.4) | 62 (26.7) | | 33 (17.4) | 34 (17.9) | |
| Grade III | 74 (31.9) | 74 (31.9) | | 21 (11.1) | 21 (11.1) | |

The combined score of dorsal joint spaces was taken as the highest value among the synovial hypertrophy scores or power Doppler scores in the dorsal joint spaces. The combined score of the multijoint spaces was taken as the highest value among the synovial hypertrophy scores in the dorsal joint spaces or the power Doppler scores in the dorsal and volar joint spaces. *, P≤0.05. MCP, metacarpophalangeal joint; IP, interphalangeal joint.

MCPs, with the middle finger and ring finger being more vulnerable among IPs. The results of our study were not completely consistent with the published literature, which is likely related to a larger fraction of patients with RA we recruited in our study. MCP synovitis was easily detected in both the volar and dorsal joint spaces, while IP synovitis was more easily detected in the volar joint spaces, which aligns with the findings of Witt *et al.* (17).

Of the 232 cases of MCP synovitis, if we only scanned the dorsal joint spaces, the missed detection rate was as high as 20.7%. Similarly, if we only scanned the volar joint spaces, the misdiagnosis rate was 17.2%. This suggests that when scanning MCP synovitis in rheumatic diseases, if we only scan single joint spaces, the missed diagnosis rate of MCP synovitis will be high. Therefore, the dorsal joint spaces recommended by EULAR-OMERACT should not be used independently, and the volar joint spaces should be also be considered. Of the 190 cases of IP synovitis, if we only scanned the dorsal joint spaces, the missed rate was as high as 47.4%; if we only scanned the volar joint spaces, the missed rate decreased markedly to 5.8%. This suggests that the dorsal joint spaces recommended by the EULAR-OMERACT should not be used when detecting IP synovitis; rather, the volar joint spaces should be preferentially chosen. The 11 patients with IP whose synovitis was detected only in the dorsal joint space all also had RA with a long course of disease. The shortest course of disease was 7 years, and the longest was more than 20 years according to the collected data. This latter case could probably be attributed to the fact that the patient had a long course of disease, accompanied by swan neck deformity, which resulted in IP hyperextension. In a hyperextensive state, the volar joint spaces are so extremely squeezed that synovitis can only be detected in the dorsal joint spaces (18,19).

### *Comparison of synovial thickness between the different joint spaces of hand synovitis under different EULAR-OMERACT GS scores*

In the EULAR-OMERACT GS scores of MCP synovitis, there was no significant difference in the thickness of the synovium between the dorsal joint spaces and the volar joint spaces when the scores were grade I and II. For grade III, the thickness of synovium of the dorsal joint spaces was higher than that of the volar joint spaces, which differ from the results of Vlad *et al.* (16), who reported a thickness of synovium of the volar joint spaces higher than that of the dorsal joint spaces with severer SH. The reason for this discrepancy may be the different score standards used. Vlad *et al.* used synovial thickness as the scoring standard, while we used the joint line and joint capsule as the reference. Furthermore, Vlad *et al.*'s study did not exclude simple joint effusion; thus, in their study, 2- to 3-mm synovitis would be classified as grade III, while we mostly classified this as grade II. For the GS scores of IP synovitis, the thickness of the synovium in grade I was higher in the volar joint spaces, and for grade II and III, it was higher in the dorsal joint spaces.

Therefore, when the degree of synovitis was mild (grade I), MCP synovitis showed no significant difference in the thickness of the synovium in the dorsal and volar joint spaces. On the contrary, the thickness of the IP synovium in the volar joint spaces was higher than that in the dorsal joint spaces. The reason for this might be related to the existence of articular capsules. The articular capsules of the IPs are present only in the volar joint spaces. However, the articular capsules of the MCPs are present in both the volar and dorsal joint spaces (20-22). When SH was severe (grade II and grade III), it was mainly detected in the dorsal

 

joint spaces. It has been speculated that the superficial surface of the volar joint space is covered with more tissue, including the palmar plate, flexor digitorum tendon, and subcutaneous fat. The palmar plate is strong, and the flexor digitorum tendon is stronger than the extensor digitorum tendon, which could limit the expansion of synovium to the volar sides (22,23).

### *Comparison of PD scores between the dorsal and volar joint spaces*

There were differences in the PD scores of the dorsal joint spaces, the volar joint spaces, and the final PD scores of MCP synovitis. The PD scores of the dorsal joint spaces were more sensitive than were those of the volar spaces. Although the final PD scores comprehensively took into consideration the blood flow signal of the dorsal and volar joint spaces, which could more thoroughly reflect the blood flow of MCP synovitis, they only improved the PD scores of the dorsal joint spaces by 5.6%. Therefore, considering the examination time, we gave priority to the dorsal joint spaces when rating the PD scores of MCP synovitis. For IP synovitis, the PD scores of the volar joint spaces were lower than those of the dorsal joint spaces and the final PD scores. Furthermore, the difference between the PD scores of the dorsal joint spaces and the final PD scores was not statistically significant, indicating the reliability of only observing the dorsal joint spaces when rating the PD scores of IP synovitis. The PD scores of hand synovitis were different between the dorsal and volar joint spaces, with most being higher in the dorsal joint spaces. These finding are in line with those of Witt *et al.* (24). The blood flow manifestation of synovitis may be affected by several factors: instrument performance; instrument setting and adjustment; probe pressure; depth of the joint synovitis position; and type, quantity, and thickness of the superficial surface of the coated tissue of the joint cavity (25,26). It has been speculated that there is good sensitivity for the dorsal joint spaces because they are shallow and the covered tissue is thin. In addition, the dorsal joint capsule is more relaxed, and the micro blood flow can be more easily detected in the natural flat state.

### *Comparison of combined scores, GS scores, and PD scores of the dorsal joint spaces*

The combined scores were higher than the GS scores or PD scores alone with respect to the dorsal joint spaces, which indicates that it may be difficult to accurately represent the actual situation of hand synovitis using only the GS or PD index alone. The result was consistent with the recommended EULAR-OMERACT combined scoring system, in which only the highest among the GS or PD scores is considered. Synovitis severity assessment includes evaluation of hypertrophy and activity. Quantitative measurement and semiquantitative scoring of synovial thickness intuitively reflect synovial proliferation, and the presence or absence of blood flow signals in the synovium reflect the activity of SH, thus reflecting disease activity (27). Therefore, evaluating the severity of synovitis by GS or PD scores alone is inaccurate. Some studies have reported PD to be more sensitive than GS in detecting synovitis. The reason for this may be that as SH tends to be located below the joint line when it is mild, it may be confused with the articular cartilage. This may also be attributable to the fact that the human eye is more sensitive to the changes in blood flow than to changes in GS (24,28). This phenomenon was not encountered in our study, which might be related to our simultaneous observation of the volar joint spaces. More specifically, we carefully confirmed the presence of SH in the dorsal joint spaces repeatedly when synovitis was suspected in the volar joint spaces.

### *Comparison of the combined scores between dorsal joint spaces and multijoint spaces of hand synovitis*

Because GS scores are not recommended as the standard in the volar joint spaces of MCP and IP synovitis according to EULAR-OMERACT, the difference of the combined scores between multijoint spaces and the dorsal joint spaces in our study was due the synovial blood flow signal in the volar joint spaces. As can be seen in *Table 6*, 48 cases of MCP synovitis and 90 cases IP synovitis were classified as grade 0 in the dorsal joint spaces. Only 6 of the 48 cases of MCP synovitis had blood flow signals in the volar joint spaces, of which 4 were grade I and 2 were grade II. Only 3 of the 90 cases of IP synovitis had blood flow signals in the volar joint spaces, all of which were grade I. These results suggest that blood flow signal is not sensitive in the volar joint spaces, which may be related to the depth of the volar joint spaces and to the fact that the shallow surface is covered with hyperechoic structures such as the palmar plate and flexor tendon, which reduce the sensitivity of the detection of PD blood flow. This is similar to the recommended examination standard of knee joints by EULAR-OMERACT (29,30). The blood flow in the knee

 

joints should be observed in both the inner and outer recesses instead of the suprapatellar capsule area, as the suprapatellar capsule is deep and the superficial surface is covered with the strong quadriceps tendon, which can reduce the sensitivity of PD instrument. We also found differences between the combined scores of dorsal joint spaces and multijoint spaces of hand synovitis. However, for 184 MCP case of synovitis with positive combined scores of the dorsal joint spaces, only 1 case with the combined score of the multijoint spaces improved from grade I to grade II. For the 100 case of IP synovitis with positive combined scores of dorsal joint spaces, only 1 case with a combined score of the multijoint spaces improved from grade I to grade II. This suggests that the dorsal joint spaces should only be considered when evaluating the PD signal of hand synovitis.

Some limitations to this study should be acknowledged. First, the work was based on a comparatively small amount research data, and thus the sample number should be expanded. Moreover, the inhomogeneous population limits the generalizability of the results. Second, only the dorsal and volar joint spaces of the hand joints were considered in this study, and the other joint spaces in other sides of the fingers were not considered. However, MCPs and IPs have lateral collateral ligaments at both sides of the joints, which limits the expansion of the joint capsule. When hand synovitis is mild, it typically appears first in the articular capsules. When hand synovitis is severe, the lateral collateral ligaments limit the expansion of synovitis to the lateral joint spaces. Therefore, hand synovitis rarely occurs in the lateral joint spaces, and exclusion of the lateral joint spaces had only a slight influence on the results of this study. Third, we did not conduct the intraobserver and interobserver reliability tests of synovial thickness measurement. However, the good intraobserver and interobserver reliability of synovial thickness measurement has been demonstrated in a previous study (31).

## Conclusions

Our findings confirmed that ultrasound examinations should be recommended to evaluate both the dorsal and volar joint spaces in MCPs when diagnosing ultrasound-detected hand synovitis. However, priority should be given to the volar joint spaces when diagnosing IP synovitis. When evaluating the degree of SH, dorsal joint spaces should be preferred in MCPs. Moreover, particular attention should be paid to volar joint spaces when IP synovitis is mild, and dorsal joint spaces should be prioritized when IP synovitis is severe. When assessing the synovial blood flow of SH, observing the dorsal joint spaces should be prioritized in MCPs and IPs. For the semiquantitative scoring of hand synovitis, the EULAR-OMERACT combined scoring system is recommended, which is determined by the higher value among the GS or PD scores. However, this study found that when grading SH, in contrast to the EULAR-OMERACT recommendation—which favors the sole use of dorsal joint spaces—the volar joint spaces should also be considered. However, there is currently no SH semiquantitative grading standard for the volar joint spaces. From our perspective, the GS semiquantitative grading standard of SH in the volar joint spaces should be examined further.

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## Footnote

*Reporting Checklist:* The authors have completed the STARD reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-23-1211/rc

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Ethics Committee of West China Hospital, Sichuan University [approval No. 2022(1691)]. Informed consent was obtained from all participants or their legal guardians.



 

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