INTEROBSERVER RELIABILITY IN ULTRASOUND ASSESSMENT OF RHEUMATOID WRIST JOINTS

Karine R. Luz*, Rita N.V. Furtado*, Sonia V. Mitraud**, Jorge Porglhof**,
Conceição Nunes*, Artur R. C. Fernandes**, Jamil Natour*

Abstract

Objective: To evaluate interobserver reliability in the ultrasound assessment of synovitis in the radiocarpal (RC), midcarpal (MC) and ulnocarpal (UC) joints in RA.

Methods: Ultrasound examinations of 295 rheumatoid wrist joints were performed over a three month period. The RC, MC and UC joints were examined using dorsal longitudinal ultrasound scans. Synovial thickening was assessed by quantitative measurement and a previously established semi-quantitative scoring system (Grades 0 to 3). Interobserver reliability was determined by the comparing the findings of two radiologists who were unaware of each other findings.

Results: The intraclass correlation coefficient (ICC) between examiners for the quantitative measurement of synovitis in the RC, MC and UC recesses were 0.508, 0.346 and 0.240 (p<0.001), respectively. Weighted kappa values using the semi-quantitative scoring system were 0.308, 0.312 and 0.153 for the RC, MC and UC joints, respectively.

Conclusion: Interobserver reliability of the ultrasound assessment in rheumatoid wrists proved good for the quantitative measurement of synovitis in the RC joint, but poor agreement was found for the MC and UC joints. Using the semi-quantitative scoring system, interobserver agreement was poor for all three joints (RC, MC and UC).

Keywords: Ultrasonography; Reliability; Wrist; Rheumatoid Arthritis.

Introduction

In recent years, musculoskeletal ultrasound has become an important diagnostic tool for rheumatic disease, as it allows the detection of the inflammatory process in intra-articular and periarticular structures as well as the identification of bone erosion[1,2]. This exam has a number of advantages over other imaging methods, including its non-invasive nature, good visualization of the joint cavity, absence of radiation, and wide acceptance by patients. The exam's dynamic and rapid execution enables it to assess multiple joints at low cost, thereby making it is a "bedside exam"[3,4]. Despite these significant advantages, ultrasound findings remain highly dependent on the individual examiner's findings. This occurs partially due to the subjective assessment of the images and the low degree of standardization of the technique due to the small number of multi-center studies involving the method[5-9].

In cases of rheumatoid arthritis (RA), the wrist is affected in 90% of patients in the first 10 years of the disease[10]. The wrist is an anatomical complex made up of various articular recesses and inter-bone ligaments. The three main recesses in the wrist are the radiocarpal (RC), midcarpal (MC) and ulnocarpal (UC)[11,12]. Ultrasound has proven useful in the assessment of these articular recesses as well as in the distinction between healthy individuals and patients with chronic inflammatory arthropathy of the wrist[13-16]. It is a helpful tool for guiding procedures, assessing sub-clinical findings and monitoring treatment[16,17].

There are few studies investigating interobserver reliability in the ultrasound assessment of musculoskeletal conditions[6-9,18-21]. The majority of these studies have analyzed ultrasound reliability for the joints of the hands and feet, knees and periarticular structures, such as in cases of rotary cuff injury[7-9,14-16]. The reliability of ultrasound assessment of

*Rheumatology Division, Universidade Federal de São Paulo – Escola Paulista de Medicina, São Paulo, Brazil.
** Department of Radiology, Universidade Federal de São Paulo – Escola Paulista de Medicina, São Paulo, Brazil.
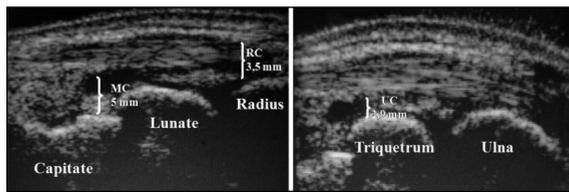
Figure 1. B-mode US synovial thickness measurements in the wrist joint, scanned in a longitudinal plane of the dorsal central and ulnar surface of radiocarpal (RC), midcarpal (MC) and ulnocarpal (UC) recess. Synovial measurements were performed perpendicular to the great axis and at the point of greatest thickness

Figure 2. Ilustration of semi-quantitative scoring system at radiocarpal joint: L – lunate; R- radius; RCJ – radiocarpal joint; JC – joint capsule; BD – bone diaphysis; * – synovial thickening

the wrist has only been evaluated regarding the presence or absence of synovitis in a small number of patients with different chronic inflammatory conditions[8-9,22]. There is no evidence of any study investigating interobserver reliability in the ultrasound assessment of the synovium in different articular recesses of the wrist.

The aim of the present study was to determine interobserver reliability in the ultrasound assessment of the radiocarpal (RC), midcarpal (MC) and ulnocarpal (UC) recesses of the wrist in patients with RA and clinical synovitis.
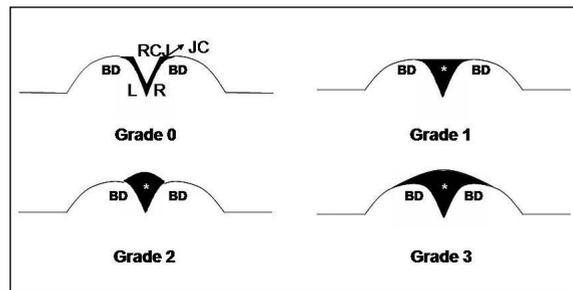
Methods

A cross-sectional study was carried out involving patients with RA based on the classification criteria of the American College of Rheumatology[23] presenting clinical synovitis in at least one of the wrists. The patients included had no diagnostic criteria for any other collagen disease

Ultrasound Assessment
Assessments were carried out by two radiologists with experience in musculoskeletal ultrasound. Two hundred and ninety five wrists of RA patients with clinical synovitis were examined by ultrasound over a three-month period. The ultrasound examinations were performed using a Sonosite 180 Plus (SonoSite. Inc – United States) device equipped with a linear probe (5 to 10 MHz).

All patients were instructed to stay seated in a comfortable position in front of the examiner with their hand in a pronated position on top of the desk to take dorsal scans in neutral position of the wrist.

The ultrasound examinations were performed from the dorsal aspect of the wrist with the transducer in a longitudinal position. The examinations

were performed from the radial and ulnar sides as well as midline to assess the RC, MC and UC recesses in accordance with the standards established by the European League Against Rheumatology[24].

Both quantitative and semi-quantitative measurements were performed in each recess for synovial thickening[13,19]. The quantitative measurement was obtained from the distance between the joint capsule and subchondral bone (Figure 1). For the semi-quantitative assessment, a modified version of a previously established semi-quantitative scoring system to evaluate metacarpophalangeal (MCP), proximal interphalangeal and metatarsophalangeal joints were used[19]. A single score was used for effusion and synovitis, ranging from 0 to 3: 0- no synovial thickening; 1- minimal synovial thickening up to the joint capsule; 2- synovial thickening causing curvature of the joint capsule, but without extending to the bone diaphysis; 3- synovial thickening with curvature of the joint capsule and extending to at least one bone diaphysis. Figure 2 displays the semi-quantitative measurement at radiocarpal joint and respective scores.

Interobserver Reliability
Interobserver reliability was determined by comparing the mean quantitative and semi-quantitative scores obtained by two radiologists who were unaware of clinical assessments. Each operator performed the ultrasound exams sequentially and independently. The assessments were performed in different rooms, using the same machine and settings, and the measurements were recorded on separate charts. Therefore, each evaluator was blinded to the measurements of the other.

Table I. Demographic parameters, disease related variables in 59 RA patients

Age, years (Mean ± SD)	48.7 (± 9.25)
Gender (Women/ Men)	55/4
Race (White/ Black)	52/7
Disease Duration, years	11.33 (± 9.61)
Functional Class	II (46)
	III (13)
Rheumatoid Factor (positive) (%)	59
Prednisone, mg/day (Mean ± SD)	6.65 (± 5.22)
Diphosphate Cloroquine (%)	7
Methotrexate (%)	89
Sulfassalazine (%)	13
Leflunomide (%)	42

SD – standard desviation

Table II. The mean quantitative measurement (mm) of synovial in the RC, MC and UC recess according to Operator A and Operator B

Recesses (Mean ± SD)	Operator A (n-295)	Operator B (n-295)	ICC (R)
RC recess (Mean ± SD)	5.09 mm (± 1.83)	4.82 mm (± 1.41)	0.482
MC recess (Mean ± SD)	4.53 mm (±1.83)	4.40 mm (±1.34)	0.509
UC recess (Mean ± SD)	5.34 mm (± 1.68)	7.03 mm (± 1.74)	0.240

RC – radiocarpal; MC – mediocarpal; UC – ulnocarpal; SD – standard desviation; ICC – intra-class correlation coefficient

Statistical Analysis

The intra-class correlation coefficient (ICC) was used for the quantitative measurements and weighted Kappa test (κ) was used for the semi--quantitative measurements. For the ICC, inte-robserver reliability was considered excellent if R > 0.75, good to optimal if R was 0.4 to 0.75 and poor if R < 0.4[25]. With the Kappa test, interobserver reliability was considered excellent if κ > 0.81, subs-tantial when values were 0.61 to 0.80, moderate when values were 0.41 to 0.60, good when values were 0.21 to 0.40, minimal when values were 0.20 to 0 and poor when the value was 0[26].

Results

Fifty-nine patients with RA were analyzed. Table I displays the demographic data and clinical parameters.

Ultrasound Assessment

A total of 295 assessments were performed on the rheumatoid wrists over a three-month period. The mean quantitative measurement of synovium in the RC, MC and UC recesses according to Opera-tor A was 5.09 ± 1.83 (1.2 – 10.12) mm, 4.82 ±1.83 (0 –11.66) mm and 5.34 ± 1.68 (1.16 – 12.23) mm, respectively. According to Operator B, these mea-surements were 4.53 ± 1.41 (1.7 – 9.9) mm, 4.40 ±1.34 (0.66 – 8.3) mm and 7.03 ± 1.74 (1.16 – 11.56) mm, respectively (Table II).

In the semi-quantitative measurements of the RC recess, Operators A and B determined a score of 1 in 147 and 164 assessments, a score of 2 in 121 and 115 measurements, and a score of 3 in 27 and 16 measurements. In the semi-quantitative mea-surements of the MC recess, Operators A and B de-termined a score of 1 in 28 and 103 assessments, respectively; a score of 2 in 164 and 126 measure-ments, respectively; and a score of 3 in 27 and 16 measurements, respectively. In the semi-quanti-tative measurements of the UC recess, Operators A and B determined a score of 1 in 97 and 118 as-sessments, respectively; a score of 2 in 152 and 117 measurements, respectively; and a score of 3 in 46 and 60 measurements, respectively (Table III).

The absolute agreement for semiquantitative scoring for both observers was 58,3% for RC, 47,5% for MC and 46,4% for UC recess.

Interobserver reliability

The ICC between the two evaluators for the quan-titative measurements of the RC, MC and UC re-cesses was 0.508, 0.3463 and 0.240 (p<0.001), res-pectively. Weighted Weighed kappa values for semi-quantitative assessments of the RC, MC and UC recesses were 0.308, 0.312 and 0.153, respec-tively (Tables II and III).

Discussion

The present study assessed the interobserver relia-bility ultrasonography for quantitative and semi--quantitative measurements of wrist in patients with long-standing RA. The wrist is one of the most affected joints in RA and is a complex anatomical structure made up of various joint recesses and pe-

Table III. Interobserver agreement for the semi-quantitative scores of the RC, MC and UC recesses according to Operator A and Operator B

Recess (n = 295)	Operator	Semi-quantitative scores (N)			kappa
		1	2	3	k
RC recess	A	147	121	27	0.308
	B	164	115	16	
MC recess	A	103	164	28	0.312
	B	66	126	103	
UC recess	A	97	152	46	0.153
	B	118	117	60	

RC – radiocarpal; MC – mediocarpal; UC – ulnocarpal; A – operator A; B – operator B

riarticular structures, which makes the physical exam of this joint a difficult task that requires the use of imaging methods[11,14,15]. A number of studies have demonstrated the ultrasound is capable of revealing inflammatory alterations in this joint. However, there are no previous studies that have evaluated the interobserver reliability of this method for joint recesses of the wrist[1-4].

In the present study, good reliability (ICC = 0.5081) was found for the RC recess, whereas poor correlations were found for the MC (ICC = 0.3463) and UC (ICC = 0.240) recesses. Likewise, poor interobserver reliability was found for the semi-quantitative assessment for all three recesses analyzed (RC, MC and UC), with Kappa values of k = 0.308, k = 0.312 and k = 0.153, respectively. Two previous studies involving experts in musculoskeletal ultrasound and the assessment of different joints found moderate interobserver reliability (k = 0.59 to 0.61) regarding the presence or absence of synovitis in the wrist; these studies report interobserver reliability similar to that found in the present study in the quantitative measurement of synovia in the RC recess[8,9]. Unlike the present study, however, these studies only performed a qualitative assessment (presence or absence of synovitis) and did not perform a quantitative measurement of synovitis. Moreover, no systematic examinations of rheumatoid wrists were carried out, but rather the evaluation of different joints and degenerative inflammatory conditions[8,9].

Iagnocco *et al.*, investigated the presence or absence of synovitis in the wrists of patients with systemic lupus erythematosus and found optimal interobserver reliability for the RC recess (k = 0.73 to 0.89)[22]. A recent study investigated interobserver reliability in the ultrasound assessment of synovitis in 28 joints in patients with RA and found

moderate reliability (k = 0.49) for the presence of synovitis in the RC recess of the wrist[27].

Few studies on ultrasound have employed a quantitative measurement of the synovia as an assessment instrument. Schmidt *et al.*, determined reference values for the measurement of the synovium in different joints in healthy individuals; in the wrist, the mean distance between the joint capsule and scaphoid bone profile was < 1.5 mm[28]. Koski (2003) established the measurement of the synovium in the recesses of rheumatoid joints and considered unequivocal synovitis to be a measurement greater than 2 mm in the RC recess and the presence of any area of synovial proliferation in the MC recess[13]. However, interobserver reliability was not determined in either of these studies.

The poor interobserver reliability (ICC = 0.346) for the quantitative measurement of synovitis in the MC recess in the present study may have occurred due to the fact that the patients had long-standing RA, in which erosion is common and the possible destruction of the carpal bones, such as the lunate and capitate, has occurred, which would hamper the visualization of the subchondral bone profile for the quantitative measurement. In the UC recess, there is a presence of the triangular fibrocartilage and the styloid process, which may have impaired the exact positioning of the transducer, thereby causing an anisotropic effect and leading to the poor reliability in the measurement of the synovium in this recess. Moreover, a portable ultrasound device of lesser resolution was used in the present study, which may have compromised the adequate localization of the joint capsule and hampered the quantitative measurement.

A semi-qualitative assessment of synovitis in the

RC, MC and UC recesses was employed in the present study, as this method is the most common form of measuring synovial thickening. For this assessment, a semi-quantitative scoring system which was previously estabilished by Szkularek *et al.*, for small joints of the hand and feet (proximal metacarpophalangeal, interphalangeal and metatarsophalangeal) was used[19]. In this study the scoring system for synovitis and joint effusion showed moderate to optimal interobserver reliability (ICC of 0.61 and 0.78, respectively) for all evaluations[19]. In the present study, the scoring system was modified to determine the presence of synovitis and joint effusion in the same assessment. This decision was made due to the fact that both alterations occur simultaneously in the chronic inflammatory process. However, there was poor interobserver reliability in the assessment of the recesses. The MCP joints used by Skzudlarek *et al.,* are considered joints with a simple anatomical model, in which the subchondral bone and cartilage may be assessed and detection of synovitis is easy[26]. An explanation for different levels of agreement between studies may be that the wrist is a more elaborate joint with diverse recesses and multiple ligament structures[11,12].

The assessment of synovial proliferation in the present study was not carried out with the aid of a power Doppler signal. This decision was made due to the low resolution of the ultrasound device in the assessment of a power Doppler, which could have compromised the results.

In conclusion, there was moderate interobserver reliability for the quantitative measurement of the synovium in the RC recess and poor reliability regarding the MC and UC recesses. The semi-quantitative assessment of the synovium using a previously established scoring system for small joints demonstrated poor interobserver correlations for the RC, MC and UC recesses of rheumatoid wrists. Further studies are needed for the standardization of a quantitative measurement of the synovium in joint recesses of the wrist as well as the validation of semi-quantitative scoring systems for this frequently affected joint in patients with RA.

Correspondence to
Jamil Natour
Disciplina de Reumatologia,
Universidade Federal de São Paulo
Rua Botucatu, 740 São Paulo,
SP – Brazil 04023-900
Phone/Fax: 55 11 5576 4239
E-mail: jnatour@unifesp.br

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