Effect of Hand Deformities on Hand Function in a Sample of Patients with Rheumatoid Arthritis

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ABSTRACT:

BACKGROUND:

Rheumatoid arthritis (RA) is a chronic systemic autoimmune inflammatory disease that commonly affects the small joints of the hands and feet, and results in irreversible joint damage, deformity, and functional impairment.

Hand function is an important domain of the health status of RA patients. Assessment of hand function, therefore, is an essential part in the follow-up of RA patients and in gauging their response to treatment.

Numerous measures were developed to evaluate the hand function. One widely accepted measure includes simple clinical tests: Key grip, ball grasp, pen grasp, pinch grip and grip strength.

OBJECTIVE:

This study aims to determine the effect of hand deformities on hand function in a sample of patients with RA.

PATIENTS AND METHODS:

A cross-sectional study was conducted on 116 randomly selected patients fulfilling the 2010 ACR/EULAR criteria for Classification of RA. Patients with other conditions that can affect the hand function were excluded.

Patients were evaluated for age, hand deformities and Disease Activity Index (DAS28). A novel score was used to combine all hand deformities into one value.

Hand function was assessed by 3 subjective tests (key grip, pen grasp and ball grasp) and 2 objective tests (pinch strength and grip strength, measured by specialized dynamometers).

RESULTS:

Objective hand function tests (mean grip strength and mean pinch strength) had significant moderate negative correlations with the score of hand deformities ($p<0.001$, $r=-0.459$ or better), while the *mean ranks of impairment* of subjective hand function tests (key grip, pen grasp and ball grasp) showed significant weak positive correlations with the score of hand deformities ($p=0.002$ or less, $r=0.283$ or more).

CONCLUSION:

The presence and degree of hand deformities are significantly associated with poor hand function in patients with rheumatoid arthritis.

KEYWORDS: rheumatoid arthritis, hand deformities, hand function.

INTRODUCTION:

Rheumatoid arthritis (RA) is a chronic systemic autoimmune inflammatory disease affecting the synovium of joints as well as extra-articular organs. [1,2]

The most common pattern of joint involvement is symmetrical inflammatory polyarthritis affecting the small joint [wrists, metacarpophalangeal (MCP), proximal interphalangeal (PIP), ankles and metatarsophalangeal (MTP) joints] then spreading to the large joints (knees, ankles, shoulders, hips, elbows and less frequently the cervical spine, acromioclavicular, sternoclavicular and temporomandibular joints) [3,4].

Chronic inflammation of the joint and periarticular structures in RA often lead to irreversible damage and deformity. The following deformities are frequently observed: Ulnar and radial deviation of the wrist, ulnar deviation of MCPs, volar subluxation of MCPs, *Boutonnière* deformity, swan neck deformity and mallet finger [4-6].

Diagnosis of RA is established clinically after exclusion of other similar diseases. [1,3] For the purpose of classifying the patients in clinical research, two sets of criteria were established: The 1987 revised American College of Rheumatology (ACR) criteria [7] and the 2010

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ACR / European League Against Rheumatism (EULAR) criteria [8].

Hand function is an essential factor in achieving a good quality of life. Assessment of hand function; therefore, is an important part, both in research and clinical practice, of gauging response to treatment and assessing the functional outcome of many diseases and conditions. [9]

Chronic inflammation of the joints of hands and wrists is in RA often results in chronic pain, muscle wasting and deformities, and these in turn lead to impaired hand function and raise the need to use assistive devices. [10,11]

For clinical practice, a set of 6 simple hand function tests was suggested. [6] It includes one quantitative (objective) test (*grip strength*, using a dynamometer or a sphygmomanometer) and five subjective tests: Pinch grip, thumb to side of index grip (key grip), pen grasp, palmar (ball) grasp and hook grasp.

OBJECTIVE:

This study aims to determine the correlation between hand deformities and hand function in a sample of patients with rheumatoid arthritis.

PATEINTS AND METHODS:

PATIENTS:

A cross-sectional study was conducted on 116 randomly selected Iraqi patients with rheumatoid arthritis attending the Rheumatology Clinic, Baghdad Teaching Hospital, Medical City in the period between December 1st, 2012 and May 15th, 2013.

All patients included in the study fulfilled the 2010 ACR / European League Against Rheumatism (EULAR) criteria for rheumatoid arthritis [8].

Patients with any condition, beside RA; that can jeopardize the hand function (e.g. overlapped systemic lupus erythematosus, diabetes mellitus, trauma to the hands, neurological diseases) were excluded from the study.

METHODS:

Full history was taken from each patient focusing on the following parameters: age, gender, occupation and patient's global assessment of disease activity (evaluated by a 0-100 visual analogue scale (VAS)).

Additionally, all patients were examined clinically and the following parameters were recorded: number of swollen joints and number of tender joints (according to the 28 joints count), and clinically-evident fixed hand deformities.

A novel index was used to combine all hand deformities into one value, the 'score of hand deformities. This score was calculated as the following: Each deformed index, middle, ring or little finger was given 1 (regardless of the type of deformity), a deformed thumb was given 4, each subluxated MCP joint was given 1 and radial or ulnar deviation of the wrist was given 3, totalling to a maximum score of 16 per one hand and 32 for both hands.

Disease activity score 28 (DAS 28) [12] was calculated and used to assess the disease activity.

Five standardized hand function tests were conducted on each hand. Of these, 3 tests were subjective and 2 were objective. These tests were performed between 8:30 and 11:30 AM and while the patients were seated comfortably in a standardized position: the shoulders were adducted and neutrally rotated, the elbows were flexed at 90 degrees and the wrists were in neutral position.

The *subjective* tests included:

(1) Thumb to the side of index grip (*key grip*): The patient was given a key and asked to hold it firmly between the thumb and the side of index, while the examiner was trying to pull it free to assess the firmness of the patient's grip on the key.

(2) Grasp (*pen grasp*): The examiner attempted to withdraw a pen grasped firmly between the patient's thumb and fingers.

(3) Palmar grasp (*ball grasp*). The patient is asked to hold a tennis ball firmly in the palm of his/her hand while the examiner attempted to withdraw it.

The *objective* tests included:

(1) Pinch strength: Peak strength of two fingers-pinch (index and thumb pinch) was measured using a Baseline® pneumatic dynamometer (Fabrication Enterprises Inc., USA).

(2) Grip strength: Peak strength of fist-grip was measured by a Baseline® digital (electronic) Smedley dynamometer (Fabrication Enterprises Inc., USA).

Each one of the subjective tests was referred to as either 'normal' or 'impaired' according to the examiner's evaluation; hence, they are designated as 'subjective'. Pinch strength was measured in PSI (pounds by square inch) and grip strength was measured in Kg (kilograms).

Data Collection and Statistics

All the data was collected and registered by one examiner using a two-page paper form and then translated into a computerized database structure. Statistical analyses were done using SPSS version 20 computer software (Statistical Package for Social Sciences) in association with Microsoft Excel 2013.

The statistical significance of difference in the mean of pinch and grip strength between 2 groups was assessed using the independent samples t-test, while between more than 2 groups ANOVA test was used. When the grouping variable in ANOVA model was an ordinal level variable (e.g. Score of hand deformity-both hands-categories) a special form of ANOVA trend (polynomial) test was used. A p value less than 0.05 was considered statistically significant.

The value of the linear correlation coefficient (r) was used to determine the strength of correlation as follows: (0 to <0.2); the correlation was considered very weak, (0.2 to <0.4); weak, (0.4 to <0.6); moderate, (0.6 to <0.8); strong, (0.8 to <1); very strong, and (1); perfect correlation. A positive r value indicates positive correlation while a negative value signifies negative (reverse) correlation.

Ethical Consideration

The study was granted ethical approval from the local ethics committee, Medical Faculty, Baghdad Teaching Hospital. All patients gave their informed consent prior to enrolment in the study.

RESULTS:

A total of 116 rheumatoid arthritis patients were included in the study, 103 (88.8%) were females and 13 (11.2%) were males, the mean age ± standard deviation (SD) was 47.5±11 years. Seventy-nine of included patients (68.1%) were housewives. Others had various occupations, ranging from administrative occupations (n=9, 7.8%) to occupations with heavy labour (n=6, 5.2%).

Average disease duration in the study sample was 10.6±7.6 years. Seventy-one patients (61.2%) had high disease activity, 40 (34.5%) had moderate disease activity, while only 2 patients had low disease activity (1.7%) and 3 patients (2.6%) were in remission (table 1). The mean DAS28 was 5.3±1.25 (Table 1). Eighty-eight patients (75.9%) were receiving Etanercept (50 mg/week), while 28 patients (24.1%) did not receive any biological agents.

Table 1: Frequency distribution of the study sample by demographic and clinical characteristics.

		N	%
1.	Age (years)		
	<40	26	22.6
	40-59	71	61.7
	60+	18	15.7
	Total	115	100.0
2.	Gender		
	Female	103	88.8
	Male	13	11.2
	Total	116	100.0
3.	Occupation		
	Administrative	9	7.8
	Health Care	4	3.4
	Teacher	13	11.2
	House Wife	79	68.1
	Labour worker	6	5.2
	Shop keeper	4	3.4
	Unemployed	1	0.9
	Total	116	100.0
4.	DAS28		
	Remission (<2.6)	3	2.6
	Low activity (2.6-3.1)	2	1.7
	Moderate activity (3.2-5)	40	34.5
	High activity (5.1+)	71	61.2
	Total	116	100.0

N; number of patients, RF; rheumatoid factor, DAS28; disease activity score (28 joints count).

Hand Deformities

Tables 2 summarizes the number and frequency of deformities encountered in the examined fingers, MCP and wrist joints.

The mean *score of hand deformities* of the patients included in the study was 5.3 ± a standard deviation of 7.2.

Table 2: Number and frequency of deformities of fingers, metacarpo-phalangeal and wrist joints.

	Right hand		Left hand		Both Hands	
	N	%	N	%	N	%
Finger deformities						
No Deformity	460	79.3	462	79.7	922	79.5
Z-deformity of thumb	25	4.3	26	4.5	51	4.4
Mallet Finger	31	5.3	18	3.1	49	4.2
Swan-Neck	41	7.1	43	7.4	84	7.2
Boutonniere	19	3.3	28	4.8	47	4.1
Claw finger	4	0.7	3	0.5	7	0.6
Total	580	100	580	100	1160	100
Number of MCP joints with volar (or dorsal) subluxation						
4	7	6.0	5	4.3	12	5.2
3	3	2.6	1	.9	4	1.7
2	3	2.6	6	5.2	9	3.9
1	6	5.2	10	8.6	16	6.9
0	97	83.6	94	81.0	191	82.3
Total	116	100.0	116	100.0	232	100.0
Number of MCP joints with ulnar or radial subluxation						
4	22	19.0	23	19.9	45	19.4
0	94	81.0	93	80.2	187	80.6
Total	116	100.0	116	100.0	232	100.0
Deformities of the wrist						
No Deformity	88	75.9	85	73.3	173	74.6
Ulnar Subluxation	21	18.1	23	19.8	44	19.0
Radial Subluxation	7	6.0	8	6.9	15	6.5
Total	116	100.0	116	100.0	232	100.0

N; number of fingers/hands, MCP; metacarpophalangeal.

Hand Function Tests

Tables 3 and 4 summarize the results of subjective and objective hand function tests, respectively.

Table 3: Frequency distribution of the study sample by subjective hand function tests.

		N	%
1.	Key Grip		
	Both hands are Normal	90	77.6
	Impaired in one hand	8	6.9
	Impaired in both hands	18	15.5
	Total	116	100.0
2.	Pen Grasp		
	Both hands are Normal	100	86.2
	Impaired in one hand	8	6.9
	Impaired in both hands	8	6.9
	Total	116	100.0
3.	Ball Grasp		
	Both hands are Normal	76	65.5
	Impaired in one hand	15	12.9
	Impaired in both hands	25	21.6
	Total	116	100.0
	N; number of patients.		

Table 4: Objective hand function tests.

	Range	Mean	SD	SE	N
Pinch strength by pneumatic dynamometer (PSI)-average of both hands	(0.3 - 9.8)	4.5	1.9	0.18	116
Grip strength by electronic dynamometer (Kg)-average of both hands	(3.1 - 41.4)	14.6	7.3	0.68	116
SD; Standard deviation, SE; standard error, N; number of patients, PSI; pound per square inch.					

Hand Function and Hand Deformities

The mean *pinch strength* and mean *grip strength* showed significant, moderately strong, negative correlations with hand deformity score ($p<0.001$, $r=-0.459$ and $p<0.001$, $r=-0.482$ respectively) (table 5).

The mean rank of key grip impairment and pen grasp impairment showed weak but significant positive correlations with hand deformity score ($p<0.001$, $r=0.35$ and $p=0.002$, $r=0.283$, respectively) (table 6).

The mean rank of ball grasp impairment showed significant moderately strong positive correlation with hand deformity score ($p<0.001$, $r=0.414$) (table 6).

Table 5: Objective hand function parameters and hand deformity score.

	Score of hand deformity (both hands) categories			
	First (lowest) quartile (No deformity)	Average-interquartile range (1 - 8)	Fourth (highest) quartile (9+)	P
Pinch strength by pneumatic dynamometer (PSI)-average of both hands				<0.001
Range	(0.8 - 9.8)	(1.8 - 8.6)	(0.3 - 5.4)	
Mean	5.1	4.7	2.9	
SD	1.8	1.5	1.6	
SE	0.26	0.25	0.31	
N	50	39	27	
r=-0.459 P<0.001				
Grip strength by electronic dynamometer (Kg)-average of both hands				<0.001
Range	(4.7 - 41.2)	(6 - 41.4)	(3.1 - 18)	
Mean	16.8	15.6	9.2	
SD	6.9	7.9	4	
SE	0.97	1.27	0.77	
N	50	39	27	
r=-0.482 P<0.001				

PSI; pounds per square inch, SD; Standard deviation, SE; standard error, N; number of patients, r; linear correlation coefficient.

Table 6: Subjective hand function parameters & hand deformity score.

	Score of hand deformity-both hands-Average categories						
	First quartile No deformity		interquartile range (1 - 8)		Fourth (highest) quartile (9+)		
	N	%	N	%	N	%	P
Key Grip							
Both hands are Normal	45	90.0	31	79.5	14	51.9	<0.001
Impaired in one hand	2	4.0	1	2.6	5	18.5	
Impaired in both hands	3	6.0	7	17.9	8	29.6	
Total	50	100.0	39	100.0	27	100.0	
Mean rank	51.2		57.9		72.9		
r=0.35 P<0.001							
Pen Grasp							
Both hands are Normal	47	94.0	33	84.6	20	74.1	0.042
Impaired in one hand	3	6.0	2	5.1	3	11.1	
Impaired in both hands	0	0.0	4	10.3	4	14.8	
Total	50	100.0	39	100.0	27	100.0	
Mean rank	53.7		59.6		65.7		
r=0.283 P=0.002							
Ball Grasp							
Both hands are Normal	40	80.0	28	71.8	8	29.6	<0.001
Impaired in one hand	5	10.0	4	10.3	6	22.2	
Impaired in both hands	5	10.0	7	17.9	13	48.1	
Total	50	100.0	39	100.0	27	100.0	
Mean rank	49.6		54.9		80.1		
r=0.414 P<0.001							

N; number of patients, r; linear correlation coefficient.

DISCUSSION:

To best of our knowledge, this is the first study to focus on the effect of hand deformities on hand function in Iraqi rheumatoid patients.

In this study, 79.5% of the examined fingers were normal and only 20.5% were deformed. The commonest deformity encountered was swan-neck deformity (7.2%), followed by Z-deformity of thumb (4.4%), mallet finger (4.2%) and boutonnière deformity (4.1%). Claw finger was present in (0.6%) only. These figures are generally lower than what other studies found, including the studies by Johnsson *et al* [13] and Madenci *et al* [14]. The difference can be attributed to genetic factors and / or discrepancies in treatment.

A novel index was used to combine all hand deformities into one value; the *'score of hand deformities'*. This score; although still needs to be verified by further studies, provided an easy to understand representation of the overall deformity of the examined hands and made incorporating the deformities into statistical analysis possible and easy.

The score of hand deformities showed a significant moderately strong negative correlation with pinch and grip strengths and a significant weak to moderate positive correlation with *impairment* of key grip, pen grasp and ball grasp. These results are in agreement with other studies. Dias *et al* [15] concluded that, in RA patients, swan neck deformity affects the grip strength more than boutonnière deformity and that the hands with combined deformities are the weakest. A 10-years cohort study conducted by Johnsson and Eberhardt [13] concluded that hand deformities of RA lead to hand impairment and disability, and has a major negative impact on daily life function. Vliet Vlieland *et al* [16] found that malalignment of the MCP joints, swan neck and Z deformities have a significant correlation with most of the hand function measures in RA patients.

These results prove that hand deformities negatively affect the hand function. Therefore, early and aggressive management plan may be necessary to prevent deformities and preserve function in RA patients.

CONCLUSION:

The presence and degree of hand deformities are significantly associated with poor hand function in patients with rheumatoid arthritis.

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