Hand function in female patients with hand osteoarthritis: relation with radiological progression

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Abstract

Objective We aimed to investigate the effect of hand osteoarthritis (HOA) on hand strength, dexterity, and upper extremity functional scores, as well as to determine the relation of radiological severity of HOA with these parameters.

Methods Sixty patients and 40 controls were enrolled in the study. The presence of hand pain, nodes, and tenderness in hand joints was determined. Grip and pinch strengths were measured by Jamar dynamometer and pinch meter, dexterity was assessed by Purdue pegboard test, and upper extremity function was determined by disabilities of arm, shoulder and hand (DASH) test. Hand radiographs were evaluated according to the Kallman grading scale.

Results The mean age of the patients and control subjects were 58.9 ± 4.8 and 56.6 ± 5.8 years, respectively. The level of hand pain and tenderness, and the number of nodes were significantly higher in the patient group than in control subjects. The mean grip and pinch strengths were lower in

the patient group; however, the difference was significant only in left lateral and left three chuck pinch. In hand dexterity, all scores except Purdue 1 were significantly lower in the patient group. In the functional evaluation DASH outcome, questionnaire scores of the patient and control groups were 48.3 ± 26.3 and 39.5 ± 23.5 , respectively ($p > 0.05$). In the patient group, Kallman scores indicating radiological severity were found to be correlated with age, DASH scores, grip and pinch strengths, and Purdue scores (except Purdue assembly). Pain by visual analog scale was significantly higher in the patient group and correlated significantly with DASH scores.

Conclusion In patients with HOA, using standardized tests for evaluations may not be adequate. The determination of grip–pinch strength, dexterity and functional disability will lead to a clearer definition of the needs of the patients and will likely increase the gains from the rehabilitation programs.

Keywords Hand osteoarthritis · Elderly · Hand dexterity · Grip strength · X-ray

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Introduction

Hand osteoarthritis (HOA) is one of the most prevalent forms of osteoarthritis (OA) [15], and typically involves the interphalangeal (IP) and carpometacarpal joints (CMC) [9]. HOA is associated with pain, reduced grip strength, loss of range of motion (ROM), and joint stiffness, leading to impaired hand function and difficulty in performance of daily living activities [25].

Radiological HOA is apparent in about 6–20 % of young adults, while this ratio increases to 80 % in the ones older than 65 years old [14]. Most people 55 years of age and over, have radiologic changes in HOA at least in one joint, and one fifth of this population is symptomatic [8]. This

condition associated with pain and disability has a significant impact on patients' lives [26].

Though studies about the relation of HOA with pinch–grip strength or radiologic alterations exist in the literature [2, 11, 23], there is limited knowledge about the relation of radiologic scores with hand dexterity, pinch–grip abilities, and functional status of the upper extremity in patients with HOA.

In this study, we aimed to investigate the effect of HOA on pinch and grip strengths, hand dexterity, and upper extremity functional scores and to determine the relation of radiological progression of HOA with these parameters.

Materials and Methods

Sixty patients and 40 control subjects who were over 50 years of age and who presented to the physical medicine and rehabilitation outpatient clinic from March to September 2009, were enrolled in the study. The patients were selected among the patients fulfilling the American College of Rheumatology HOA criteria [1]. The exclusion criteria were the presence of other hand and wrist conditions such as a tunnel syndrome, tendonitis, history of major hand trauma or surgery of the hand, or of neurologic diseases causing sequelae in the hand, inflammatory arthritis, and endocrine diseases (diabetes mellitus, thyroid disease, etc.). Those with a psychiatric disorder were also not included in the study. The control group was constituted from among the patients who attended the outpatient clinic due to low back pain or knee pain, having no clinical symptoms referable to hand joints.

The study was approved by the ethics committee of the hospital. The subjects were instructed about the study, and written informed consents were obtained before enrollment. The study was cross-sectional in design. In the beginning, 68 patients were selected for the HOA group. There were eight drop-outs: only three of the patients were male, and they were thus excluded as their number was too small for statistical analysis; and five patients did not attend appointments for evaluation. Forty-five patients were chosen as the control group; three of them declined to participate in the study and two were from the commuter towns and could not return for an evaluation.

Demographic variables including age, weight, height, dominant hand, occupation, and comorbid diseases were recorded. Presence of hand pain was evaluated on a 0–100 mm visual analog scale (VAS). In the physical examination, tenderness in hand joints, presence of nodes in proximal and distal IP joints (PIP and DIP respectively), CMC joint involvement, ROM of the finger joints were determined. All assessments were done by the same physiatrist. A finger goniometer was used for ROM assessments. Strength measurements were performed on both hands of the subjects.

Grip strength was measured by a Jamar hydraulic hand dynamometer and pinch strength was determined by a Jamar

hydraulic pinch gauge (Sammons Preston, Bolingbrook, IL, USA). Grip measurement was performed with the elbow at about 90° according to the American Hand Physiotherapists Association, and the average value of three measurements was recorded [22]. Pinch strength was measured with respect to three standard positions: tip-to-tip pinch (between tip of thumb and index finger), lateral pinch (between the pad of the thumb and the medial-lateral surface of the index finger), and three chuck pinch (between the pad of the thumb and the pads of the index and middle fingers). Three consecutive measurements were performed and the average was recorded for each subject [12].

Hand dexterity was evaluated by Purdue pegboard test. The test consists of right hand, left hand, both hands, and assembly parts, and was performed according to specific measurements [5].

Hand and upper extremity disability was tested by the disabilities of arm, shoulder and hand (DASH) outcome questionnaire, which has been found to be reliable and validated in Turkish patients. The test consists of 30 questions about hand and upper extremity functions and is scored on a 0–4 scale where 0 indicates no difficulty or no symptom, and 4 indicates unable to perform or very severe symptom [16, 18].

In the radiographic evaluation, bilateral posteroanterior hand radiographs were taken from all patients. The radiographs were evaluated by the same radiologist according to the Kallman grading scale. On each radiograph, individual joints were graded for the presence and severity of six selected individual features of OA: osteophytes, joint space narrowing, subchondral sclerosis, subchondral cysts, lateral deformity, and cortical collapse. Osteophytes and narrowing were differentiated into three grades while others were scored as absent or present (two grades). Lateral deformity was defined as malalignment of at least 15° [17].

Statistical Analysis Data were analyzed by using the Statistical Package for the Social Sciences, version 15. The distribution of constant variables was searched by Shapiro–Wilk test. The importance of differences was studied by the Student's *t* test for normally distributed variables and by the Mann–Whitney *U* test for non-normally distributed variables. Categorical variables were evaluated by Pearson's or Fisher's exact chi-square test.

Among patient and control groups, the statistical significance of radiological scores and clinical parameters was searched by Bonferroni-corrected Spearman's correlation test; a value of $p < 0.05$ was accepted as statistically significant.

Results

Sixty patients and 40 controls between 50 and 80 years of age were enrolled in the study; all the patients and controls

Table 1 The demographic characteristics of the groups

Variable	Patient group (<i>n</i> =60)	Control group (<i>n</i> =40)	<i>p</i> Value
Age (years)	58.9±4.8	56.6±5.8	>0.05
BMI (kg/m ²)	30.9±4.9	33.5±4.6	=0.010
Pain (VAS, mm)	47±23	26±25	<0.001
Hand usage history			>0.05
Tailor	9 (15 %)	4 (10 %)	
Lace making	14 (23.3 %)	12 (30 %)	
House cleaning	10 (16.7 %)	5 (12.5 %)	
Pastry	2 (3.3 %)	3 (7.5 %)	
Garden work	17 (28.3 %)	9 (22.5 %)	

BMI body mas index, VAS visual analog scale

were female and right-handed. The demographic characteristics of the groups are shown in Table 1. The control group had a higher body mass index (BMI) than the patient group. In the patient group, histories of sewing, gardening, and housecleaning were more common. The patients generally did not have a family history of HOA. The most frequently encountered comorbid diseases were coronary artery disease, chronic obstructive lung disease and hypertension, present in 9, 1.7, and 41.7 % of patients and in 5, 2.5, and 62.5 % of controls, respectively; the difference was not statistically significant.

Severity of pain by VAS was significantly higher in the patient group than in the controls (4.7±2.3 versus 2.6±2.5; *p*<0.001). The mean VAS was correlated significantly with DASH scores in the patient group (*r*, 0.445; *p*, 0.000).

The mean numbers of Heberden and Bouchard nodules, existence of CMC joint involvement, and existence of pain, swelling and redness are shown in Table 2. These variables were found to be significantly higher in the study group than in the control subjects.

Grip and pinch strengths of the patient and control groups are indicated in Fig. 1. Though all strengths were lower in the patient group, the difference was statistically significant only in left lateral and left three chuck pinch values. In hand dexterity by Purdue pegboard, all scores except Purdue 1 (right hand) were significantly lower in the patient group than in the control subjects (Fig. 2).

In the functional evaluation, DASH scores were 48.3±26.3 and 39.5±23.5 in the patient and control groups, respectively. Though DASH scores were higher in the patient group, the difference was not significantly different between the groups.

Kallman radiological scores of the right and left hands of the subjects are shown in Table 3. The difference between Kallman scores of the patient and control groups was significant (*p*<0.001). Kallman scores of the left and right hands of the patient group were statistically similar.

When we evaluated the correlation of major variables with right and left Kallman scores in the patient group, we found significant correlation with age, DASH scores, grip and pinch strengths, and Purdue scores(except Purdue assembly; Table 4). Jamar grip strength, lateral pinch, tip-to-tip pinch, and three chuck pinch scores as well as Purdue pegboard scores were correlated negatively with radiological scores, whereas DASH scores and patient age were correlated positively with Kallman scores.

Discussion

As a part of the aging process, hands undergo both functional limitation and shape deterioration. Progressive loss of articular cartilage and associated disruption of subchondral bone, joint margins, and periarticular structures in PIP, DIP

Table 2 Clinical properties of the patient and control subjects

Variable	Patient group (<i>n</i> =60)	Control group (<i>n</i> =40)	<i>p</i> Value
Heberden nodules	7.9±2.7 (0–10)	1.2±1.5 (0–5)	<0.001
Bouchard nodules	3.2±2.7 (0–9)	0	<0.001
CMC involvement			<0.001
Absent	22 (36.7 %)	35 (87.5 %)	
Unilateral	10 (16.7 %)	2 (5 %)	
Bilateral	28 (46.7 %)	3 (7.5 %)	
Swelling	11 (18.3 %)	4 (10 %)	>0.05
Redness	0	1 (1.7 %)	>0.05
DASH score	48.3±26.3	39.5±23.5	>0.05

CMC carpametacarpal, DASH disabilities of arm, shoulder and hand

Fig. 1 Grip and pinch strengths. *JR* Jamar right, *JL* Jamar left, *PTR* pinch tip-to-tip right, *PTL* pinch tip-to-tip left, *PLR* pinch lateral right, *PLL* pinch lateral left, *PThR* pinch three chuck right, *PThL* pinch three chuck left

or CMC joints are mainly responsible for these changes [1]. As a result, patients suffer from pain, joint deformity, reduced hand strength, and decreased function in hand-related activities [11]. In this study, we investigated the effect of HOA on pinch and grip strengths, hand dexterity, and upper extremity functional scores. We also assessed the relationship of radiological severity of HOA with these parameters.

We evaluated hand OA both by counting Heberden and Bouchard nodules and determining CMC involvement, and we also determined radiological scores from hand X-rays. All of our patients were female and used mainly their right hands in daily activities.

Among the patient group, 68.5 % had Heberden nodules (mean number, 7.9), 65 % had Bouchard nodules (mean number, 3.2) and 16.7 % had unilateral and 46.7 % bilateral first CMC joint involvement. In the study of Dillon et al., these values were 58 % for Heberden nodules, 29.9 % for Bouchard nodules and 18.2 % for CMC joint involvement, which were lower than ours [10]. The mean age of the HOA group was 58.8 ± 4.8 years, which was similar to other studies in the literature [6, 24]. When we asked about usage of hand joints during daily routine, we found that sewing and gardening were more common in the patient group, both of which necessitate repetitive usage of the 1st CMC joint.

In the literature, occupations involving repetitive thumb use and jobs that do not permit enough rest periods during the day were found to be associated with increased risk for 1st CMC OA [13].

Grip and pinch strength measurements are important indices of the functional integrity of the hand. In our study, though all of the mean pinch and grip measurements were lower in the patient group, the difference was significant only in the left lateral and left three chuck pinch measurements. Similar to our findings, Bagis et al. implied that patients with HOA had lower grip and pinch strengths [2]. In contrast, Baron et al. did not find a correlation between hand function, grip strength, and OA in their study group. Their study suggested that hand function and strength were related more to neuromuscular condition than to the articular degeneration [3].

The DASH symptom scale can be used to evaluate patients with disorders of the upper extremity. The DASH values of our patients were higher than in the controls but the difference was not significant. In previous studies, grades 3 and 4 HOA were cited as having a negative effect on hand functions, but they concluded that this decrease in hand function did not result in a significant disability [2, 23]. In two recent studies about HOA, self-reported pain and

Fig. 2 Purdue scores of the patients and controls

Table 3 Kallman scores of the patients and controls

	Patient group (<i>n</i> =60)	Control group (<i>n</i> =40)	<i>p</i>
Right Kallman score	18.6±17.2(0–74)	6.1±8.1(0–31)	<0.001
Left Kallman score	19.8±19.5(0–81)	4.8±6.5(0–28)	<0.001

function were measured with the Australian/Canadian OA hand index (AUSCAN) and health-related quality of life by the Short-Form 36, HOA was found to be associated with higher AUSCAN scores, and the health-related quality of life was found to be lowered [7, 20]. Similar to these studies, we also found higher DASH scores in HOA patients, though not statistically significant.

Pain, deformity, swelling of the joints, and decrement in joint ROM may have an effect on hand functions and fine hand skills. Fine hand skills are important in daily living activities and can be measured by specific tests. We used the Purdue pegboard test for this purpose. Purdue scores of the patient group were lower than in controls, with the exception of Purdue 1. Purdue 1 tests the functional ability of the right hand in placing the pins. As all of our patients were right-handed and used their right hands dominantly in daily routines, the manipulation ability of their right hands might not have deteriorated. This is the first study evaluating fine hand skills in patients with HOA; therefore, we were unable to compare our results with previous literature. In a previous

study in which the nine-hole peg test was used for comparison of dexterity between the Heberden and Bouchard nodes-positive and -negative elderly groups, the nodes were found to be unrelated with dexterity [19]. In another study, pain and stiffness were cited for influencing the dexterity [4], we found no correlation between VAS-pain and fine hand skill functions.

Radiological evaluations were made according to Kallman scores. Kallman radiological scoring is a method developed for evaluating osteophyte formation, joint space narrowing, subchondral sclerosis, subchondral cyst, lateral deformity, and collapse in all IP, first CMC and trapezioscapoid joints of the hand. In a study comparing different radiologic methods, the Kallman method was found as the most sensitive in evaluating the newly formed alterations [21]. In our study, we found that radiological scores were significantly correlated with all pinch–grip strengths, fine skills, and hand function. Generally, our findings were similar to those of Dahaghin et al., which implied that the presence of radiological HOA showed a modest to weak

Table 4 Correlation of clinical measurable variables with right and left radiological scores in the patient group

Variable	Right radiological score (<i>n</i> =60)	Left radiological score (<i>n</i> =60)
Age	<i>r</i> =0.487 <i>p</i> =0<0.001	<i>r</i> =0.507 <i>p</i> =0<0.001
VAS	<i>r</i> =0.171 <i>p</i> >0.05	<i>r</i> =0.178 <i>p</i> >0.05
Jamar grip	<i>r</i> =−0.374 <i>p</i> =0.004	<i>r</i> =−0.397 <i>p</i> =0.006
Lateral pinch	<i>r</i> =−0.300 <i>p</i> =0.006	<i>r</i> =−0.270 <i>p</i> =0.023
Tip–tip pinch	<i>r</i> =−0.310 <i>p</i> =0.016	<i>r</i> =−0.351 <i>p</i> =0.006
Three chuck pinch	<i>r</i> =−0.250 <i>p</i> =0.02	<i>r</i> =−0.320 <i>p</i> =0.011
Purdue right	<i>r</i> =−0.257 <i>p</i> =0.025	–
Purdue left	–	<i>r</i> =−0.297 <i>p</i> =0.022
Purdue bilateral	<i>r</i> =−0.350 <i>p</i> =0.007	<i>r</i> =−0.382 <i>p</i> =0.004
Purdue assembly	<i>r</i> =−0.221 <i>p</i> >0.05	<i>r</i> =−0.213 <i>p</i> >0.05
DASH	<i>r</i> =0.289 <i>p</i> =0.024	<i>r</i> =0.300 <i>p</i> =0.017

VAS visual analog scale, DASH disabilities of arm, shoulder, and hand

association with clinical symptoms [8]; the only difference being that they found a correlation with hand pain while we did not. Purdue assembly, which was the last part of the test and was more complicated, had no correlation with radiological HOA. This might be due to the fact that HOA is not a disease causing primarily deterioration in hand movement coordination. Zhang et al. found poor correlation between the clinical signs and symptoms, and radiographic findings [26], and Ozkan et al. determined no association between radiological HOA and grip–pinch strengths and Jebsen test [23]. However, contrary to these findings, Dominick et al. reported decreased grip and pinch strength with increased radiographic severity [11]. Consistent with Dominick's results, we also found negative correlations with grip and pinch strengths and positive correlation with DASH scores.

Conclusion

We found that hand osteoarthritis affects all grip and pinch strengths, hand dexterity, and upper extremity functional scores. We identified that hand strength including grip strength, left lateral pinch strength, bilateral tip and three chuck strength, and hand dexterity and function, demonstrated significant correlations with radiological scores. These functional tests also appear to correlate best with HOA-related dysfunction.

In conclusion, certain standardized tests do not appear to provide functional assessment of HOA. Therefore, we suggest integrating the tests with the clinical evaluation of patients with HOA in order to define the needs and increase the gains obtained from hand rehabilitation programs.

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