THE RELATIONSHIP BETWEEN RADIOLOGIC SEVERITY AND GRIP AND PINCH STRENGTH IN HAND OSTEOARTHRITIS

EL OSTEOARTRİTİNDE EL KAVRAMA VE PARMAK UCU KAVRAMA GÜCÜ İLE RADYOLOJİK EVRELEMENİN İLİŞKİSİ

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ABSTRACT

OBJECTIVE: *The aim of this study is to investigate the relationship between pinch and grip strength and the radiologic severity of hand osteoarthritis (HOA) in different hand joints.*

MATERIAL AND METHODS: *Fifty-five patients (17 male, 38 female) with HOA between ages 46-85 and 49 control subjects (31 female, 18 male) without HOA between ages 45-86 were included in the study. Hand radiograph of the patients were scored according to Kellgren Lawrence (KL) scale. Grip and pinch strength of hands was measured using a Jamar dynamometer and a pinchmeter. Visual analogue scale (0-10 scale) was used for pain intensity. Examination of hand consisted of palpation of Heberden and Bouchard knodes and crepitation of first carpometacarpal (CMC) joints in both hands.*

RESULTS: *Severity of pain by VAS was significantly higher in the patient group than in the controls ($p<0.001$). Though grip and pinch strengths were lower in the patient group, the differences were not statistically significant ($p>0,05$). There were negative but weak correlations between grip strength ($r=-0,253$, $p<0,001$), pinch strength tip to tip ($r=-0,212$, $p<0,001$), three chuck ($r=-0,208$, $p<0,001$) and KL score of the patient group. Grip and pinch strength values of the KL grade 1 patients were higher than KL grade 2,3,4 patients but the difference did not reach statistically significant levels ($p>0,05$).*

CONCLUSION: *These results may suggest that the HOA group had higher prior pinch and grip strength values and this higher muscle strenght may be responsible for the development of HOA.*

Keywords: *Hand, Osteoarthritis, Grip Strength, Pinch Strength*

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ÖZ

AMAÇ: *Çalışmamızın amacı, farklı el eklemlerindeki el osteoartritinin (EOA) radyolojik evresi ile el kavrama gücü ve parmak ucu kavrama güçlerinin ilişkisini değerlendirmektir.*

GEREÇ VE YÖNTEM: *Çalışmaya 46-85 yaş arası, 55 (17 erkek, 38 kadın) EOA hastası ve 45-86 yaş arası 49 (31 kadın, 18 erkek) EOA olmayan sağlıklı kontrol dahil edildi. Hastaların el grafileri Kellgren Lawrence (KL) skalasına gore skorlandı. El kavrama ve parmak ucu kavrama gücü Jamar dinamometre ve pincmetre kullanılarak ölçüldü. Görsel analog skala (GAS) (0-10), ağrı değerlendirmek için kullanıldı. Elin değerlendirilmesi her iki elde Heberden ve Bouchard nodüllerinin palpasyonu ve birinci karpometakarpal (KMK) eklemde krepitasyon aranması ile yapıldı.*

BULGULAR: *Ağrının ciddiyetinin değerlendirildiği GAS düzeyi hasta grubunda kontrol grubuna gore belirgin olarak yüksekti ($p<0.001$). Hasta grubunun el kavrama ve pinch kavrama gücü kontrol grubuna göre daha düşük olmasına rağmen fark istatistiksel olarak anlamlı değildi ($p>0,05$). El kavrama ($r=-0,253$, $p<0,001$) ve parmak ucu ($r=-0,212$, $p<0,001$), üç parmak ($r=-0,208$, $p<0,001$) pinch kavrama değerleri, hastaların KL skorlarıyla zayıf korelasyon gösteriyordu. El kavrama ve pinch kavrama gücü KL düzey 1 olanlarda, KL düzey 2,3,4 olanlara gore daha yüksekti ancak istatistiksel anlamlı düzeye ulaşmadı ($p>0,05$).*

SONUÇ: *Bu bulgular EOA hastalarının hastalıktan önceki kavrama güçlerinin daha iyi olup bu artmış kas gücünün EOA gelişimine yatkınlığa neden olabileceğini düşündürmektedir.*

Anahtar kelimeler: *El, Osteoartrit, El kavrama gücü, Parmak ucu kavrama*

INTRODUCTION

Hand osteoarthritis (HOA) is one of the most prevalent forms of osteoarthritis (OA), and typically involves the interphalangeal (IP) and carpometacarpal joints (CMC) (1). The etiology of OA is likely to be multifactorial and includes such mechanisms as biomechanics of joint loading and stress, hormonal factors, and genetics (2,3). The hand is a frequent site of disease involvement in OA. It has been estimated that more than 70% of people aged 65 years older are affected. HOA is more common in men up until middle age, but at about the time of menopause it becomes more prevalent in women (4).

The number of muscles, soft tissue restraints and joints involved even in simple daily tasks make the relationship between muscle activity and joint load in the hand more complex. Muscle activity is the major determinant of strength in hand joints, and high muscle forces are sustained at certain hand joints during gripping which is one of the common tasks in daily living. Muscle activity in the hand takes primary role while holding an object. The load over joints changes according to the type of muscle activity. The compressive force across the articular surface is much higher in the proximal interphalangeal joints (PIP) and metacarpophalangeal joints (MCP) than in the distal interphalangeal joints (DIP) during grasp, briefcase grip, holding a glass or opening a jar. It is widely accepted that grip strength provides an objective index of the functional integrity of the upper extremity (7). Physical and occupational therapists commonly measure grip strength to monitor the success or failure of their treatment programs (6).

The aim of this study is to investigate the relationship between pinch and grip strength and the radiologic severity of HOA in different hand joints.

MATERIAL AND METHODS

Patients were recruited through the Ankara Training and Research Hospital Physical Medicine and Rehabilitation outpatient clinic. Fifty-five patients with hand OA (17 male, 38 female) who were diagnosed according to American College of Rheumatology (ACR) criteria (7) for HOA and 49 control subjects (31 female, 18 male) who had not HOA were included in the study. History of disease, dura-

tion of complaints and Visual Analogue Scale (VAS) were inquired for each patient. VAS (0-10 scale) was used for pain intensity. Examination of hand consisted of palpation of heberden and bouchard knodes and crepitation of first CMC joints in both hands. The exclusion criteria were the presence of other hand and wrist conditions such as a carpal 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 subjects were instructed about the study, and written informed consents were obtained before enrollment. The study was cross-sectional in design. Demographic variables including age, weight, height, dominant hand and comorbid diseases were recorded.

Ages of the patient and control groups ranged between 46-85 years (mean 62,23±6,97) and 45-86 years (mean 63,4±7,43), respectively. Plain hand radiographs were taken and evaluated using the same techniques. Each joint on hand radiographs of the patients was graded for the presence of osteophytes, joint space narrowing, sclerosis, and cysts according to the modified Kellgren/Lawrence (KL) scale (range 0-4). Each second and third DIP and PIP joint and first CMC joint (10 joints in all) were scored for the presence of; I) bony enlargement or deformity; and II) pain on motion or tenderness on palpation (According to ACR criteria for osteoarthritis) (7).

The standart, adjustable-handle Jamar dynamometer (Preston Jackson, MI 49203, USA), which has been reported as the most accurate instrument for measuring grip strength, was used (8).

The B&L (Model no PG60, USA) pinch gauge, used to measure tip to tip, three chuck, and lateral pinch were held by the examiner at the distal end to prevent dropping. 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 (9). Scores were read on the needle side of the red readout marker. The calibration of both instruments was testing periodically during the study. Grip and pinch strengths were measured in sitting position with the elbow in 90˚ of flexion.

Statistical Analysis

Data were analyzed by using the Statistical Package fort he Social Sciences, version 15. 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

Dominant site was right for all of the patients and controls. There was no significant difference according to age and BMI between groups. Sex distribution had no significant difference in both groups. The demographic characteristics of the groups and joint involvements of the patient group were shown in table 1. Severity of pain by VAS was significantly higher in the patient group than in the controls (4,35±1,97 (1-9) versus 1,3±2,2 (1-2) $p<0.001$). The mean numbers of 2. and 3. digits Heberden and Bouchard nodules, existence of CMC joint involvement, and VAS values are shown in table 2.

Though grip and pinch strengths were lower in the patient group, the differences were not statistically significant ($p>0,05$) (Table 2). Also, patient and control groups were divided further according to genders. In both groups, men have much higher grip and pinch strength values than females ($p<0,001$). There were no differences in grip and pinch strength values between patient and control groups with respect to their genders, as values of the male patients and their controls were not different, similar to the female groups and their controls ($p>0,05$). The correlation analysis were conducted in 110 hands of the 55 patients and shown in table 3. There were negative correlations between grip strength (r_-0,616, $p<0,001$), pinch strength tip to tip (r=-0,576, $p<0,001$), three chuck (r=-0,579, $p<0,001$), lateral (r=-0,538, $p<0,001$) and VAS values. There were also nega-

tive but weak correlations between grip strength (r=-0,253, p<0,001), pinch strength tip to tip (r=-0,212, p<0,001), three chuck (r=-0,208, p<0,001) and KL score.

The patient group was divided into four groups according to their KL radiological scores (1-4). Grip and pinch strength values of the KL grade 1 patients were higher than KL grade 2, 3, 4 patients but the difference did not reach statistically significant levels (p>0,05) (Figure 1).

Table 1: The demographic characteristics of the groups and joint involvements of the patients

	Patient Group (n=55)		*Control Group (n=49)*		*p*
Age	62,23±6,97 (46-85)		63,4±7,43 (45-86)		>0,05
Sex (Female/Male)	38/17		31/18		>0,05
BMI kg/m2	31,9±3,7		32,5±5,6		>0,05
VAS	4,35±1,97(1-9)		1,3±2,2(1-2)		<0,01
Kellgren Lawrence Score					
1	6(10,9)				
2	32(58,2)		-		
3	13(23,6)				
4	4(7,3)				
	Right	Left	Right	Left	
Heberden nodules n(%)					
2.DIP Joint	54(98,2)	49(89,1)	-		
3.DIP Joint	35(63,6)	34(61,8)			
Bouchard nodules n(%)					
2.PIP Joint	5(9,1)	3(5,5)	-		
3.PIP Joint	3(5,5)	3(5,5)			
CMC involvement	32(58,2)	16(29,1)	-		

BMI: Body Mass Index
VAS: Visual Analogue Scale
DIP: Distal interphalangeal
PIP: Proximal interphalangeal
CMC: Carpometacarpal

Table 2: Grip and Pinch Strength values of the Groups.

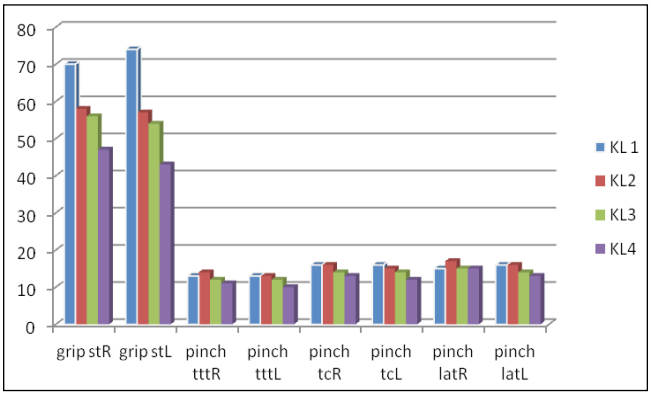
	Patient Group (n=55)		*Control Group (n=49)*		*p*
	Right	Left	Right	Left	
Grip Strength (pound)	58,4±20,49	57,54±21,67	59,02±21,25	58,3±21,13	>0,05
Pinch Strength (pound)					
Tip to Tip	13,7±4,08	13,36±4,03	14,14±4,77	14,59±3,78	>0,05
Three Chuck	16,07±4,21	15,03±4,33	17,12±4,85	16,46±5,03	>0,05
Lateral	16,58±4,47	15,63±4,39	17,79±5,05	16,69±4,28	>0,05

Table 3: Correlations among pain, radiological scores and pinch and grip strength values of group 1.

	r	*p*
VAS-Grip Strength	-0,616	<0,001
VAS-Pinch Strength		
Tip-to-Tip	-0,576	<0,001
Three Chuck	-0,579	<0,001
Lateral	-0,538	<0,001
VAS-CMC İnvolvement	0,269	0,016
KL Score-Grip Strength	-0,253	0,008
KL-Score-Pinch Strength		
Tip-to-Tip	-0,212	0,026
Three Chuck	-0,208	0,026
Lateral	-0,086	>0,05

VAS: Visual Analogue Scale
CMC: Carpometacarpal
KL: Kellgren Lawrence Radiologic Score

Figure 1: Grip and Pinch Strength Values of the patients group according to Kellgren Lawrence Grade



KL: Kellgren Lawrence
St: strength
Ttt: tip to tip
Tc: three chuck
Lat: lateral

DISCUSSION

In this study we evaluated HOA both by counting Heberden and Bouchard nodules and determining CMC involvement, and we also determined radiological scores from hand X-rays. 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 not statistically significant.

In a longitudinal study Chaisson et al. have been shown a stronger effect of grip strength in men for the development of HOA than in women. Men have much higher grip strength (10), which could result in increased load across the articular surface, perhaps leading to joint damage. In men, higher maximal grip strength was associated with an increased risk of OA in the PIP, MCP and thumb base joints. In women, there was increased risk of OA in the MCP joints. They found no association between maximal grip strength and the development of OA in the DIP joints of either men or women. Because maximal forces at DIP site are attained during pinching rather than grasping, which tends to load the proximal joints (5). In our study we found that men have much higher grip strength than women. But there was no association between grip and pinch strength and PIP or DIP joint involvement in both KL scores, bony enlargement or deformity and pain. Also there were no differences in grip and pinch strength values between patient and control groups with respect to their genders, as values of the male patients and their controls were not different, similar to the female groups and their controls.

In our study second and third DIP, PIP joints and first CMC joint (10 joints in all) which have been shown to be the most frequently affected with disease process and previously used to define generalized OA were scored (2,11). MCP and wrist joints are usually spared in OA whereas DIP, PIP, IP thump, 1st CMC, hip and knee joints are the main targets (11,12). PIP involvement is associated with affected joint count and bilateral involvement.

The method of grading radiographic changes of OA, developed by Kellgren and Lawrence in 1957 and adopted by the World Health organization in 1961, has been accepted as the gold standard for both cross-sectional and longitudinal studies. The basis of the Kellgren/Lawrence scale is the presence of osteophytes, which is considered the pathognomonic feature of OA (13). In our study, grip and pinch strength values of the KL grade 1 patients were higher than KL grade 2,3,4 patients but the difference did not reach statistically significant levels.

Zhang et al. found poor correlation between the clinical signs and symptoms, and radiographic findings (14). Baron et al. did not find a correlation between hand function, grip strength, and OA in their study group. They suggested that hand function and strength were related more to neuromuscular condition than to the articular degeneration (15). Ozkan et al. determined no association between radiological HOA and grip–pinch strengths and Jebsen test (16). However, contrary to these findings, Dominick et al. reported decreased grip and pinch strength with increased radiographic severity (17). Ceceli et al. found that radiological scores which determined with Kallman radiological scoring were significantly correlated with all pinch–grip strengths and hand function (18). Dahaghin el al., implied that the presence of radiological HOA showed a modest to weak association with clinical symptoms and they found a correlation with hand pain (19). Similar to these results, we found that radiological KL scores were weakly, pain was moderately correlated with grip and pinch strength values of patients.

It is accepted that there is a loss of muscle strength in old age. The reasons for loss have been studied and are thought to include loss of muscle mass which occurs because motor neurons die and reinnervation does not keep pace with the loss, or because muscle cells shrink through lack of use. A variety of chronic diseases may directly affect musculoskeletal system, like OA and are also likely to diminish feelings of well-being and so reduce levels of physical activity which will in turn increase disuse atrophy (20). Despite articular injury, our patients performed similar muscle activity according to normal subjects. It may be considered that the OA group had higher prior pinch and grip strength values than normal subjects.

CONCLUSION

Articular injury in OA may lead to muscle weakness. Radiographic severity of the involved joints in HOA negatively correlated with grip and pinch strength, however grip and pinch strength were not significantly different among groups. It may be considered that the OA group had higher prior pinch and grip strength values and this higher muscle strength may be responsible for the development of hand OA. Increased grip strength, which is the result of excessive muscle strength, may contribute to the pathogenesis of hand OA.

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