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Associations between Radiographic Changes and Function, Pain, Range of Motion, Muscle Strength and Knee Function Score in Patients with Osteoarthritis of the Knee

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Abstract.[Purpose] The purpose of this study was to examine the association between the radiographic stages of knee osteoarthritis and measurements of symptoms. [Subjects] One hundred eighty-three patients with radiographs of varying degrees of osteoarthritis of the knee and 35 healthy subjects with no osteoarthritis of the knee were assessed. [Methods] The participants were assessed using the Hospital for Special Surgery score, pain score, sit-to-stand test, manual muscle test, goniometry and the Kellgren-Lawrence score. [Results] While pain scores of grades I and II in the Kellgren-Lawrence score were similar to each other, they were less than the pain scores of grades III and IV. Muscle strength, function scores and range of motion of grades I and II were similar and they were also higher than the values of grades III and IV. Pain scores of grades III and IV were similar whereas muscle strength, range of motion and function scores of grade IV were lower than those of grade III. While there was no difference between the functional levels of grade II and III, they were both lower than the values of grade I but higher than the values of grade IV. [Conclusion] The radiological findings did not show very strong relationships with other symptoms and signs of the disease in osteoarthritic patients.
Key words: Osteoarthritis, Radiography, Symptoms

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INTRODUCTION

Osteoarthritis (OA) of the knee is a common clinical problem[1)] for which the advice of either a physiotherapist or an orthopaedic surgeon is sought[2)]. Its management has considerable direct and hidden health care costs, and consequently it imposes a major socio-economic burden[3, 4)]. The signs and symptoms of knee OA include pain, limitation of joint motion, joint stiffness and inflammatory signs[5)]. Also, quadriceps femoris weakness is a frequent early complaint of patients with knee OA[6–8)]. There is a discordance between radiographic knee OA and symptomatic knee OA[2, 4, 8–16)]. A direct relationship has been described between measures of radiographic knee OA and pain or functional disability by some[4, 10–13)] but not all researchers[2, 8, 9, 14–16)]. Because of this asymptomatic people with radiographic changes seldom seek medical attention for OA[17)]. There is controversy in the medical literature about how important radiographic features are in evaluating knee OA. As many surgeons depend on radiographic changes when selecting patients for

arthroplasty or referring them to rehabilitation, it is important to have a clear understanding about the relationship between function and radiographic changes[2]. There are some differences between the outcomes of the studies which have examined the relation between OA grade and pain, locomotor disability and quadriceps femoris strength[2, 4, 8–16]. In some of these studies, healthy controls and Kellgren-Lawrence grade II, III and IV osteoarthritic patients were compared[4, 8–12], whereas others compared the candidates for arthroplasty surgery (grade II, III, IV in the Kellgren-Lawrence score)[2]. Some authors suggest that further studies investigating the relationship between symptoms and radiographic changes of patients with different degrees of OA cartilage damage are needed[4, 18]. The purpose of this study was to investigate and compare parameters such as pain, locomotor function, range of motion, muscle strength of healthy persons and patients with different OA grades.

SUBJECTS AND METHODS

Subjects

Data was acquired for 218 people aged 28–83 years, with an average age of 61.5 ± 10.1 years. There were 35 subjects in the healthy group (20 male, 15 female), 33 subjects in the grade I OA group (8 male, 25 female), 30 subjects in the grade II OA group (4 male, 26 female), 59 subjects in the grade III OA group (11 male, 48 female), and 61 subjects in the grade IV OA group (2 male, 59 female). All OA patients had a clinical diagnosis of knee OA made by an orthopaedic surgeon and fulfilled the American College of Rheumatology criteria for OA[19]. As a comparative group, 35 healthy control subjects were recruited from the community who were in good general health and lived independently. Participants of the control (healthy) group gave no history of knee pain or other symptoms and for ethical reasons no X-rays were taken.

Methods

Radiological OA was assessed by means of the grading system proposed by Kellgren and Lawrence[20]. The Kellgren and Lawrence classification method is as follows: grade 0=normal, I=doubtful osteophyte, II=definite osteophyte, III=moderate joint space narrowing and IV=severe joint space narrowing[20]. Standing anteroposterior and lateral radiographs of both knees of each study participant were obtained, and the severity of OA in the tibiofemoral compartment was graded by two independent orthopaedic surgeon readers who were blind to all data of the participant. The knee function of all patients was evaluated using the Hospital for Special Surgery (HSS) Knee score criteria, which is based on a total of 100 points. The score is divided into seven categories: pain, function, range of motion, muscle strength, flexion deformity, instability, and substractions. Scores between 100 and 85 points are considered as excellent results; scores between 84 and 70 points are good results; scores 69 and 60 points are fair, and scores less than 60 are considered as poor results[21]. Pain severity was measured by the pain subscale of HSS knee score criteria[21]. Range of motion was determined with a universal goniometer as the degree of knee flexion[22]. Functional level was evaluated by the sit-to-stand (STS) test. Subjects were asked to rise from a 16-inch high chair while keeping their arms folded across their chest. Each subject performed one practice and two recorded trials[21]. The quadriceps femoris (patient was instructed to extend the knee while sitting on the treatment table) muscle strength was manually evaluated against gravity and resistance[22].

Statistical analyses were performed with SPSS for Windows (version 15.0, SPSS Inc., Chicago, Illionis). Differences between the groups of patients with different radiographic grade were examined with analysis of variance and the Mann-Whitney U test (manual muscle test). A p value of < 0.05 was considered as significant.

RESULTS

Means and standard deviations and ranges of scores within the different radiographic grades are given in Table 1. While BMI was similar for healthy people and grade I and II patients, it was greater in the higher grades (grade III and IV). When the degree of knee flexion of healthy subjects and osteoarthritic patients were compared, grade I and II patients had knee flexion degrees similar to healthy controls, but grade III and IV patients had less knee flexion degrees than the others. Grade IV patients had less knee flexion degrees than grade I, II and III patients (Tables 1, 2). When the pain levels of osteoarthritic patients were compared, the pain

Table 1. Values of demographic variables, range of knee motion, pain, knee function score, functional level and muscle strength scores between different radiographic grades.

Variables	Healthy Subjects (n=35)	KL grade I (n=33)	KL grade II (n=30)	KL grade III (n=59)	KL grade IV (n=61)
Age (years)	58.1 ± 4.2 (50–65)	50.9 ± 11.0 (28–74)	59.6 ± 9.0 (37–76)	65.7 ± 9.2 (46–82)	66.9 ± 7.7 (50–83)
BMI (kg/m^2)	28.5 ± 4.2 (17.3–37.7)	28.4 ± 4.9 (19.1–37.6)	27.7 ± 2.8 (19.4–34.1)	30.7 ± 4.8 (21.3–50.2)	30.7 ± 5.2 (21.6–44.3)
Active knee flexion (°)	119.6 ± 7.1 (105–135)	122.0 ± 10.6 (92–135)	121.0 ± 12.9 (72–135)	105.1 ± 14.4 (60–138)	92.2 ± 20.9 (20–120)
HSS pain subscale	30.0 ± 0.0 (30–30)	20.0 ± 6.7 (0–30)	21.0 ± 6.0 (10–30)	12.6 ± 5.5 (0–30)	11.5 ± 5.9 (0–25)
HSS score	86.8 ± 7.6 (64–93)	80.0 ± 13.2 (48–99)	82.0 ± 13.5 (42–100)	67.7 ± 12.5 (36–98)	59.25 ± 13.66 (31–93)
STS test	D: 0, I: 35	D: 3, I: 30	D: 16, I: 14	D: 29, I: 30	D: 45, I: 16
Q.F. Strength	4.7 ± 0.5 (4–5)	4.8 ± 0.3 (4–5)	4.8 ± 0.3 (4–5)	3.9 ± 0.5 (3–5)	3.7 ± 0.6 (2–5)

KL: Kellgren and Lawrence, Values are expressed as means ± SD, BMI: Body mass index, HSS: Hospital for Special Surgery, STS: Sit-to-stand D: Dependent, I: Independent, Q.F.: Quadriceps femoris. X ± SD (Range).

Table 2. P values of the comparison of the groups.

	Age	BMI	Active knee flexion	HSS pain subscale	HSS score	STS test	Q.F. Strength
Healthy subjects vs KL grade I	0.001	0.865	0.230	0.000	0.002	0.072	0.306
Healthy subjects vs KL grade II	0.407	0.365	0.564	0.000	0.030	0.000	0.365
Healthy subjects vs KL grade III	0.000	0.030	0.000	0.000	0.000	0.000	0.000
Healthy subjects vs KL grade IV	0.000	0.038	0.000	0.000	0.000	0.000	0.000
KL grade I vs KL grade II	0.001	0.535	0.619	0.351	0.402	0.000	0.900
KL grade I vs KL grade III	0.000	0.029	0.000	0.000	0.000	0.000	0.000
KL grade I vs KL grade IV	0.000	0.037	0.000	0.000	0.000	0.000	0.000
KL grade II vs KL grade III	0.004	0.002	0.000	0.000	0.000	0.713	0.000
KL grade II vs KL grade IV	0.000	0.004	0.000	0.000	0.000	0.040	0.000
KL grade III vs KL grade IV	0.448	0.975	0.000	0.188	0.000	0.005	0.010

KL: Kellgren and Lawrence, BMI: Body mass index, HSS: Hospital for Special Surgery, STS: Sit-to-stand Q.F.: Quadriceps femoris.

levels of grades I and II were similar, while pain was greater in grades III and IV; the pain levels of grades III and IV were similar (Tables 1, 2). Knee function scores were lower for osteoarthritic patients than for healthy controls. Knee function scores of grades I and II were similar, though they were higher than the values of grades III and IV. The functional score of grade IV was lower than grade III (Tables 1, 2). In the STS test, osteoarthritic patients showed lower independent status than the healthy controls. While there was no difference between the functional levels of grades II and III, both grades had lower functional scores than grade I, but these scores were and higher than that of grade IV (Tables 1, 2). When the muscle strength was compared, similar results were seen for healthy subjects and grade I and II patients. However, grade III and IV patients had lower muscle strength values. The muscle strength of grade IV was lower than that of grade III (Tables 1, 2).

DISCUSSION

In this study, we found that the radiological findings of patients with knee OA did not show any strong relationships with other symptoms and signs of the disease. However, a correlation between higher grades of OA (grade III and IV) and symptoms was found.

In patients with knee OA, quadriceps femoris

weakness is a clinical feature that has been described several times before[2, 3, 6–8, 17, 18, 23, 24]. It is considered to be an important determinant of disability[8, 18, 24]. According to our results, quadriceps femoris strength decreased as OA grade increased (Table 1). Our results are similar to the results of some studies[6, 17, 23, 24] nevertheless they contradict the results of others[2, 18]. We agree with Bruyere et al.[10] that conflicting results are most likely due to the heterogeneity of the studied population, the radiographic data and the clinical criteria for evaluation. Previous research has shown that knee extensor strength is a highly prevalent and modifiable risk factor for disability in people who have OA and in elderly people without pain[8, 18, 24]. In patients with light to moderate OA of the knees, regular strengthening exercise is possible and leads to an improvement in muscle strength, endurance, and speed[7]. These strength increases are associated with reduction in disability, which substantiates the association between quadriceps femoris weakness and disability, and emphasizes the importance of quadriceps femoris exercises in the management of patients with early stage knee OA[3]. Our findings suggest that clinicians caring for patients with knee OA should monitor quadriceps femoris strength and recommend quadriceps femoris strengthening exercises in order to maintain and improve dynamic stability. Quadriceps femoris strength is important in maintaning dynamic stability during the common basic and instrumental activities of daily living.

Unlike other studies that found association between pain and radiographic changes by using the Kellgren and Lawrence scale[4, 10–13], our study showed that pain severity was not correlated with radiographic damage (Table 1). This finding confirms earlier observations regarding the associations between the radiographic severity and pain[2, 8, 9, 14–16].

The ability to rise from a chair is an important task of daily living[25, 26]. This movement is easily influenced by a variety of neurologic and orthopedic problems. For physiotherapists, clinical evaluation of sit-to-stand movement is important when treating patients with limited functional activity[26]. The chair rise test is one of the activities used in functional indexes and in test batteries of physical functioning[27]. A large impact of radiological OA of the knee on disability in activities of daily living is related to lower limb function[8, 15]. McAlindon et al.[8] reported an increased risk of locomotor disability in people with pain and radiological OA of the knees. In the present study, we found that the independence level of patients, as measured by the STS, was lower than that of the healthy controls. In addition to this, there was no relation between the OA grade and the independence level. For example, the independence levels of grade II and grade III patients were similar (Table 1). The findings of the present study show that radiographic severity was not correlated with functional disability, a result which is in accordance with the outcomes of some studies[2, 4, 10, 15, 16, 28] but contrary to those of others[6, 13, 29, 30]. We agree with Bruyere et al.[10] that the conflicting results are most likely due to the heterogeneity of the studied population, the radiographic data and the clinical criteria for evaluation.

In many studies investigating the association between the radiological findings and symptoms of knee OA, ROM of the knee was not included[4, 6, 8, 10–18, 24, 29, 30]. In the present, we investigated the ROM of the knee. According to our results, as radiographic degree increased, ROM of the knee decreased (Table 1).

Interestingly, radiological findings and objective measures of joint damage have occasionally been reported as not being significantly associated with knee function score[2, 28]. However, many studies have stated that radiological findings are correlated with knee scores[8, 11, 13, 15, 29, 30]. According to our results, as OA grade progressed, the knee function scores decreased (Table 1). Our results confirm the latter studies' findings[8, 11, 13, 15, 29, 30].

In this study, we found that the radiological findings of patients with OA did not show any strong relationships with the other symptoms and signs of the disease. However, a correlation between higher grades of OA (grades III and IV) and symptoms was found. Consequently, when planning the treatment of osteoarthritic patients (medical, exercise, arthroplasty, ... etc.), it is important to pay attention to not only radiological findings but also other signs and symptoms. Since the results of this study suggest that physical and radiographic examination of the knee OA (HSS, quadriceps femoris strength, pain, ROM, ability to rise from a chair and radiological test) cover different dimensions of the functional outcome, their combined use provides the clinician a more complete evaluation of his patients and also allows more appropriate decisions for treatment strategy.

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