Relationship Between Clinical and Radiographic Findings in Osteoarthritis Knee: A Cross-Sectional Study

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Abstract
Several studies have suggested that there is a high discrepancy between clinical and radiographic knee osteoarthritis. The objectives of this study were to examine association between radiographic classification and clinical manifestations of knee osteoarthritis, and to determine if the assessment of individual radiographic features was superior to the general radiographic scale in establishing such a relationship. A total of 125 patients with knee osteoarthritis were enrolled in this study. Radiographic features were assessed with the Kellgren-Lawrence grade scale for general radiographic grading, and a line-drawing atlas for detailed radiographic analysis. The severity of knee pain, stiffness, and disability were measured using the Western Ontario and McMaster Universities Osteoarthritis Index. Patients’ age and pain duration were found to correlate significantly with knee pain, stiffness, and disability. No association between general radiographic grading scale and clinical manifestations was found. However in detailed radiographic analysis, osteophyte site at the patellofemoral joint was found to correlate with knee stiffness. In conclusion, radiographic scores were not found to be closely associated with the clinical features of knee osteoarthritis. The results of knee X-rays should not be used in isolation when a management decision is to be taken for patients with knee osteoarthritis.

Keywords
Knee osteoarthritis; Radiographic; Relationship; Symptoms

Introduction
Osteoarthritis (OA) is the most common degenerative joint disorder and a major public health problem throughout the world. It affects any joint containing hyaline cartilage12 and the knees are the most commonly affected joints30. Diagnosis of OA is usually based on symptoms (clinical OA) and is confirmed by radiography41. Pain is the predominant symptom of knee OA and the main reason for medical consultation. It is also a cause of disability, especially...
Materials and Methods

The protocol of this cross-sectional study was approved by the Research and Ethics Committee, King Abdulaziz University. Each subject provided written informed consent prior to entering the study. Between May 2012 and January 2014, one hundred and fifty four (154) adult patients with knee OA fulfilling the American College of Rheumatology (ACR) Criteria \(^{17}\) and who met the inclusion eligibility to be recruited in this study. Of them, 125 patients were found to be eligible. Exclusion criteria were patients under 18 years of age, patients with other rheumatologic diseases, serious systemic illness, malignancy, history of knee surgery and patients who received intra-articular injections. Weight was measured to the nearest 0.1 kg after removal of clothes and heavy clothing using a digital hospital column scale (Seca North America, Chino CA USA). Height was measured to the nearest 0.1 cm without shoes using the telescopic measuring rod for the column scale. From these data, Body Mass Index (BMI) (weight/height\(^2\); kg/m\(^2\)) was calculated and classified according to the World Health Organization (WHO) criteria\(^{18}\). The WOMAC scale was used to measure pain, stiffness and physical function of each subject\(^{16}\). The scale consists of 24 items divided into 3 subscales: 5 for pain, 2 for stiffness and 17 for physical function. Each item is scored using the Likert Scale as: none, mild, moderate, severe, and extreme. These terms correspond to an ordinal scale of 0-4. The scores are summed for items in each subscale. A total WOMAC score is created by summing the items for all three subscales. The WOMAC Index has been used extensively in clinical trials, and has generally been shown to exhibit greater or comparable responsiveness to change than other tests. This varies however, for different subscales and types of interventions. The test-retest reliability of the WOMAC varies for the different subscales. The pain subscale has not been consistent across studies, but it generally meets the minimum standard. The physical function subscale is more consistent, and has stronger test-retest reliability. The stiffness subscale has shown low test-retest reliability\(^{19}\).

Radiographic assessment of the symptomatic knee(s) of each participant was done using 2 scales: Kellgren-Lawrence (K-L) grading scale of the posteroanterior (PA) films\(^{10}\), and a line drawing atlas for grading of knee OA\(^{20}\). In this study, three views for each symptomatic knee(s) were chosen: the fully extended weight bearing (PA) view for assessment of the tibiofemoral (TF) joint, and both the lateral supine view with the knee flexed to 45° plus the skyline view for the assessment of the patellofemoral (PF) joint. Similar sensitivity was found between combination of PA plus skyline and PA plus lateral views\(^{21}\). Each radiograph was evaluated separately by two readers: M.S. and E.A., who were blind to patients’ clinical details. The first reader, M.S. has over 20 years’ experience in reading the musculoskeletal and joint radiographs as a senior consultant in physical medicine, rheumatology and rehabilitation, while E.A. has four years’ experience reading knee OA films as a senior resident physiatrist. In addition, E.A. underwent a period of initial training on the K-L scale interpretation. Each reader gave his score according to the K-L grading scale, followed by comparison of results. In cases with conflicting scores, the radiographs were re-read by both readers together to reach a common score. Next, the radiographs were assessed by the reader M.S. for the detailed line drawing atlas (LDA). The LDA\(^{20}\) was designed to overcome some of the theoretical and practical problems faced when using the photographic atlases of the Osteoarthritis
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Research Society International (OARSI). The LDA consists of a series of logically developed line drawings of the extended posteroinferior view of the medial and lateral tibiofemoral joints (TF) and skyline view of the PF joint for grading joint space width (JSW) and osteophyte. Osteophyte size was translated as 0 = No osteophyte, 1 = Small osteophyte, 2 = Medium osteophyte and 3 = Large osteophyte. Where discrepancy existed in the score of osteophyte size within one site, the higher grade was chosen as a total grade, i.e., if the osteophyte size in the medial tibial area was scored 3 while in the medial femoral area was scored as 2, the osteophyte size in the medial TF compartment was given a score of 3. As in osteophyte size, joint space narrowing for each site was scored as 0 = no narrowing, 1 = mild narrowing, 2 = moderate narrowing and 3 = severe narrowing. The LDA improved and enhanced face and content validity compared with the OARSI atlas. Comparison of both atlases demonstrated similar reproducibility [20].

Statistical Analysis

All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 16.0 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to describe demographic characteristics. Spearman’s rank correlation coefficients were calculated to determine the relationships between non-parametric data. Differences between the clinical parameters by the radiographic grade were examined using analysis of variance. In all analyses, P values <0.05 were considered statistically significant.

Results

One hundred and twenty-five patients with knee OA who visited the physical medicine and rehabilitation clinic, and were eligible for the current analysis were enrolled in this study. Their ages ranged between 32 and 87 (mean 56.71 ± 10.05) years.

On the radiographic assessment, 115 (46%) knees were grade 2 K-L scale, while 84 (33.6%) knees were grade 3 showing that most of the patients fall in the range of mild to moderate for radiographic features of OA severity. The demographic details, clinical, and radiological characteristics of the patients are presented in Table 1. Table 2 shows the demographic data of the studied patients in different OA severity grades according to the K-L grading scale. The detailed radiographic findings, including joint space narrowing grades, osteophyte sites and sizes in the 3 knee compartments, are shown in Table 3. Moderate narrowing of the medial TF joint was detected in 47.6% of patients. Medial and lateral TF joints were involved concurrently by osteophytes in 54.4% of patients. With regards to the PF joint, moderate narrowing was detected in 46.8% of cases with involvement of both the upper and lower margins with osteophytes in 52.4% of patients. Small sized osteophytes were reported in 42.8% and 48.8% of cases in the TF and PF joints.

Table 1. Demographic features, clinical, and radiographic characteristics of the patients.

| Parameter          | Range          | (mean ± SD)     |
|--------------------|----------------|-----------------|
| Age (years)        | 32–87          | 56.71±10.05     |
| BMI (Kg/m²)        | 18.90–48.80    | 31.16±5.69      |
| Disease duration (years) | 1.0–20.0     | 3.92±3.77       |
| WOMAC              |                |                 |
| Pain               | 1.0–19.0       | 10.81±2.37      |
| Stiffness Score    | 0.00–8.0       | 2.18±2.18       |
| Physical Function  | 0.0–62.0       | 23.28±13.49     |
| Total Score        | 3.0–96.0       | 36.27±16.28     |
| BMI                | Normal         | 18 (14.40%)     |
|                    | Overweight     | 32 (25.60%)     |
|                    | Obesity        | 75 (60.00%)     |
| Gender             | Female         | 114 (91.20%)    |
|                    | Male           | 11 (8.80%)      |
| K-L Scale          | Grade 0        | 9 (3.60%)       |
|                    | Grade 1        | 12 (4.80%)      |
|                    | Grade 2        | 115 (46.0)      |
|                    | Grade 3        | 84 (33.60%)     |
|                    | Grade 4        | 30 (12.00%)     |

SD: Standard Deviation; BMI: Body Mass Index; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; K-L: Kellgren-Lawrence Scale.

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respectively. A highly significant positive correlation between the K-L grading scale and each parameter of the detailed radiographic study was found; all with \( p \) value of < 0.000 (Table 4).

Table 5 demonstrates the significantly positive correlations found between the BMI and all WOMAC sub-scores, age of the patients and pain duration. Pain duration was also found to positively correlate with the physical function sub-score of WOMAC. None of the WOMAC sub-scores were found to be related with K-L grading scale. On the other hand, all WOMAC sub-scores were found to have positive significant relation with each other (\( p < 0.01 \)) as illustrated in Table 6. From all the detailed radiographic studies, only the osteophyte site at the PF joint is shown to

Table 2. Values of demographic variables and WOMAC scores between different radiographic grades.

|                   | K-L Grade 2 |          | K-L Grade 3 |          | K-L Grade 4 |          |
|-------------------|-------------|----------|-------------|----------|-------------|----------|
|                   | Mean        | SD       | Range       | Mean     | SD          | Range    |
| Age               | 54.09       | 9.75     | 32-75       | 59.66    | 10.07       | 36-87    |
| BMI               | 31.13       | 5.32     | 18.9-44.4   | 31.51    | 5.81        | 19.8-44.3|
| Pain Duration     | 3.30        | 2.85     | 1-15        | 4.34     | 4.30        | 1-20     |
| WOMAC pain        | 10.89       | 2.36     | 9-19        | 10.85    | 2.42        | 9-19     |
| WOMAC stiffness   | 2.14        | 2.29     | 0-8         | 2.17     | 2.06        | 0-7      |
| WOMAC function    | 22.16       | 15.04    | 2-62        | 24.10    | 12.23       | 0-51     |
| WOMAC total       | 35.20       | 18.10    | 11-80       | 37.12    | 15.00       | 10-27    |

SD: Standard Deviation; BMI: Body Mass Index; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; K-L: Kellgren-Lawrence Scale.

Table 3. Detailed radiographic findings in the studied patients.

| Joint Space Narrowing | TF Joint | PF Joint |
|-----------------------|----------|----------|
| No Narrowing          | 11 (4.40%) | 24 (9.60%) |
| Mild Narrowing        | 42 (16.00%) | 69 (27.60%) |
| Moderate Narrowing    | 119 (47.60%) | 93 (37.20%) |
| Sever Narrowing       | 78 (31.20%) | 64 (25.60%) |

TF: TibioFemoral; PF: PatelloFemoral.

Table 4. Correlation between Kellgren-Lawrence radiographic scale and the detailed radiographic characteristics of the patients.

| Detailed Radiographic Data (N=250) | KL Scale | R  | p    |
|------------------------------------|----------|----|------|
| Narrowing at medial TFJ            | .652     | 0.000 |
| Narrowing at lateral TFJ           | .375     | 0.000 |
| Osteophyte size at TFJ             | .627     | 0.000 |
| Osteophyte site at TFJ             | .345     | 0.000 |
| Osteophyte site at PFJ             | .364     | 0.000 |
| Osteophyte site at PPJ             | .292     | 0.000 |
| Narrowing at PFJ                   | .453     | 0.000 |

TF: TibioFemoral joint; PF: PatelloFemoral joint; KL: Kellgren-Lawrence radiological scale.
have a significant positive correlation with the WOMAC stiffness sub-score (P < 0.05) as shown in Table 7.

**Discussion**

This cross-sectional study investigated the relationship between the radiographic status of patients with knee OA, and their clinical manifestations and functional capabilities. This study also investigated whether the use of detailed analysis of individual radiographic features was superior to the general K-L scale in establishing such a relation. To the authors’ current knowledge, no previous inquiry into the relationship between the detailed radiographic changes - in the form of degree of joint space narrowing and osteophytes’ site and size - and the WOMAC severity index in patients with knee OA has been published.

Obesity is a well-documented and important risk factor for the development of knee OA\(^{22,24}\). These results demonstrate that BMI was significantly correlated with all WOMAC sub-scores. In a recent study, Weiss found that when taking into account OA severity, individuals with a higher BMI experience greater pain than individuals with a lower BMI, and that weight loss may reduce knee OA pain even if the osteological symptoms remain untreated\(^{25}\).

In this study, WOMAC sub-scores were found to correlate with the age of the patients and pain duration. McAlindon et al.\(^{14,26}\) demonstrated that knee pain and age are more important determinants of functional impairments in elderly subjects than the severity of knee OA as assessed by radiographic features.

Due to the fact that pain is the main complaint and the primary cause of physical disability among patients with knee OA\(^{27}\), and as the risk of disability increases with the presence of knee pain in the community\(^{28,29}\), knee pain was chosen as the clinical parameter of knee

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**Table 5.** Correlation between clinical parameters and functional disability score of the patients

| Clinical Parameter | BMI(r) | Pain Duration(r) | WOMAC Pain(r) | WOMAC Stiffness(r) | WOMAC Function (r) | WOMAC Total (r) |
|--------------------|--------|------------------|---------------|--------------------|-------------------|-----------------|
| Age                | -0.259 | 0.096            | 0.042         | -0.013             | -0.021            | -0.013          |
| BMI                | 1.00   | 0.205            | 0.199         | 0.373              | 0.199             | 0.242           |
| Pain Duration      | 0.205  | 1.00             | 0.126         | -0.040             | 0.183             | 0.164           |

\(^{P < 0.05 \text{ and } P < 0.01.}\)

BMI: Body mass index, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.

**Table 6.** Correlation between Kellgren-Lawrence radiographic scale and WOMAC scale, and correlations within the WOMAC scale.

| Parameter                   | WOMAC Pain(r) | WOMAC Stiffness(r) | WOMAC Function (r) | WOMAC Total (r) |
|-----------------------------|---------------|--------------------|-------------------|-----------------|
| Kellgren-Lawrence Scale     | 0.049         | 0.024              | 0.082             | 0.073           |
| WOMAC Pain                  | 1.00          | 0.360†             | 0.531†            | 0.604*          |
| WOMAC Stiffness             | 0.360†        | 1.00               | 0.564*            | 0.650*          |
| WOMAC Function              | 0.531†        | 0.564*             | 1.00              | 0.987†          |

\(^{P < 0.01.}\)

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.

**Table 7.** Relationship between WOMAC scale and detailed radiographic findings (ANOVA)

| Parameter                    | WOMAC Pain (F) | WOMAC Stiffness (F) | WOMAC Function (F) | WOMAC Total (F) |
|------------------------------|----------------|---------------------|--------------------|-----------------|
| K-L scale                    | 0.580          | 0.035               | 0.805              | 0.663           |
| Narrowing Medial TFJ         | 0.277          | 0.028               | 1.160              | 0.791           |
| Narrowing Lateral TFJ        | 0.316          | 1.816               | 0.794              | 2.48            |
| Narrowing PFJ                | 0.360          | 0.901               | 1.025              | 1.046           |
| Osteophytes Size TFJ         | 0.339          | 0.076               | 1.912              | 2.053           |
| Osteophytes Site TFJ         | 0.285          | 0.077               | 0.658              | 0.520           |
| Osteophytes Size PFJ         | 0.253          | 2.232               | 0.479              | 0.613           |
| Osteophytes Site PFJ         | 0.542          | 3.459*              | 0.409              | 0.676           |

\(^{P < 0.05.}\)

ANOVA: Analysis of Variance; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; K-L = Kellgren Lawrence radiographic scale; TFJ = Tibiofemoral joint; PFJ = Patellofemoral joint.
OA in the studies that investigate the relation between the clinical and radiological severity of knee OA. In the current study, an association between K–L grading scale and WOMAC subscore (pain, stiffness and physical function) could not be established. However, when detailed radiographic analysis was used, the osteophyte site at the PF joint was found to correlate with the WOMAC stiffness sub-score.

There is a widespread belief that a high discrepancy exists between clinical and radiographic knee OA[30-32]. A number of authors report that they have failed to find a strong association between pain scores and radiographic changes[7,33-37]. The postulated reason behind such discordance is the variability in radiographic definition of OA, which affects the number of cases diagnosed to have the disease and therefore the prevalence of radiographic OA disease. For example, in the knee the joint contains three compartments and if the only X-rays considered are the PA view, then only osteoarthritis in the medial and lateral compartments would be identified, and up to 24% of patients with radiographic knee OA would be undiagnosed due to failure to visualize the PF joint[38]. This study aimed to avoid this pitfall by having the 3 compartments of the knee - including the PF compartment - examined by radiograph. On the other hand, some studies[26,35,39,40] have found that radiographic features of osteoarthritis were significantly associated with knee pain. Results from an observational study have demonstrated that there was a strong dose-response relation of the severity of radiographic knee OA to the prevalence of frequent knee pain, consistent frequent knee pain and pain severity[41].

Fewer studies attempt to link radiographic changes with function. This study was unable to establish an association between the grades of radiographic changes, and the functional disabilities of the patients in the form of physical function sub-score of WOMAC index. This is consistent with Larsson et al.[42,43] who reported that radiographic diagnosis of osteoarthritis was not related to functional capacity. Creamer et al. [44] found that function was determined by pain and obesity rather than by structural changes as seen on X-ray.

Potential limitations of this study are its cross-sectional design rather than longitudinal follow up. Moreover only the WOMAC scale was used, which reflects subjective data rather than the actual functional level of patients.

The authors conclude that the relationship between the radiographic and the clinical features of knee OA is not well established and that the radiographic assessment alone is of limited benefit in predicting the functional level of the patient. It is suggested that to choose among the available management plans for knee OA, either rehabilitation or surgery, both the clinical and radiographic evaluation are to be considered. Additional longitudinal studies using objective clinical measures of knee OA, such as the quadriceps muscle strength or range of motion, are recommended for more accurate identification of the rate of radiological changes and its relationship with the functional level of the patients.

Conflicts of Interest

The authors have no conflict of interest.

Disclosure

None of the authors received any type of commercial support either in forms of compensation or financial for this study. They have no financial interest in any of the products or devices, or drugs mentioned in this article.

Ethical Approval

Obtained.

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المستعرضة

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المستعرضة

آشارت العديد من الدراسات أن وجود تباين كبير بين التقييم السريري والتقييم الإشعاعي لالتهاب الركبة. لكهذا البحث كهداف دراسة العلاقة بين التقييم الإشعاعي والمظاهر السريرية لالتهاب الركبة وتحديد ما إذا كان التقييم التشخيصي للتصوير الإشعاعي تتفق على الدراسة العامة للتصوير الإشعاعي في أخذ مثل هذه العلاقة. وقد شملت هذه الدراسة 120 مريضًا بخسونة الركبة. تم تقييم التصوير الإشعاعي للمريض بطريقتين مختلفتين: احديهما تفصيلية باستخدام أطس ممرضين والأخرى عامة باستخدام مقياس (كالجو رونتس) كما تم استخدام مؤشر الجامعات أونتاريو وماكاستير الغربيين (WOMAC) لالتقاط المفصل والتي تشمل قياس شدة ألم الركبة والطلب، والعجز. كانت النتائج هي العثور على ارتباط بين المؤشر WOMAC مع التقدم في السن ودرجة الألم. ولم يعثر على أي ارتباط بين المقياس العام للاستقرار ومقياس المؤشر WOMAC للأشعة والمقياس مومن الخطأ وجدت علاقة وثيقة بين وجود الرواند العظمية في مفصل الرضة تحت التصوير الجهيني. في الختام، لم يتم العثور على ارتباط وثيق بين نتيجة التصوير الإشعاعي والمظاهر السريرية للالتهاب الركبة. أن نتائج الأنشطة السينية للركبة لا ينبغي أن تستخدم بمفردها عند اتخاذ القرار العلاجي لمرضى التهاب الركبة.