

Evaluation of the Relationships Between Kellgren–Lawrence Radiographic Score and Knee Osteoarthritis–related Pain, Function, and Muscle Strength

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Abstract

Background: Knee osteoarthritis (OA) diagnosis using Kellgren–Lawrence scores is commonly used to help decision-making during assessment of the severity of OA with assessment of pain, function and muscle strength. The association between Kellgren–Lawrence scores and functional/clinical outcomes remains controversial in patients with knee OA.

Objects: The purpose of this study was to examine the relationships between Kellgren–Lawrence scores and knee pain associated with OA, function during daily living and sports activities, quality of life, and knee muscle strength in patients with knee OA.

Methods: We recruited 66 patients with tibiofemoral knee OA and determined knee joint Kellgren–Lawrence scores using standing anteroposterior radiographs. Self-reported knee pain, daily living function, sports/recreation function, and quality of life were measured using the knee injury and OA outcome score (KOOS). Knee extensors and flexors were assessed using a handheld dynamometer. We performed Spearman’s rank correlation analyses to evaluate the relationships between Kellgren–Lawrence and KOOS scores or muscle strength.

Results: Kellgren–Lawrence scores were significantly negatively correlated with KOOS scores for knee pain, daily living function, sports/recreation function, and quality of life. Statistically significant negative correlations were found between Kellgren–Lawrence scores and knee extensor strength but not flexor strength.

Conclusion: Higher Kellgren–Lawrence scores were associated with more severe knee pain and lower levels of function in daily living and sports/recreation, quality of life, and knee extensor strength in patients with knee OA. Therefore, we conclude that knee OA assessment via self-reported KOOS and knee extensor strength may be a cost-effective alternative to radiological exams.

Key Words: Function; Knee; Osteoarthritis; Pain; Radiography.

Introduction

Knee pain and disability are common in older people with knee osteoarthritis (OA) (Farrokhi et al, 2016). Pain associated with knee OA reduces a patient’s ability to engage in daily living, sports, and leisure activities, and adversely affects quality of life (Kiadaliri et al, 2016). Several risk factors are associated with knee OA, including aging, previous his-

tory of knee injury, obesity, weak knee extensor and flexor strength, and female sex (Luc-Harkey et al, 2018; Silverwood et al, 2015; Zhai et al, 2006). Among these, high body mass index and knee extensor strength are the most important (Luc-Harkey et al, 2018; Silverwood et al, 2015).

Kellgren–Lawrence classification is reliable method and widely used in clinical settings to assess the severity of radiographic knee OA (Ersoz and Ergun,

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2003). Kellgren-Lawrence score (range 0-4) addresses the joint space narrowing and osteophyte development (Ersoz and Ergun, 2003). However, the association between Kellgren-Lawrence score and knee pain remains controversial. Some previous studies have shown that radiographic score is weakly associated with knee pain in patients with knee OA (Bedson and Croft, 2008; Hannan et al, 2000). However, another study demonstrated a strong association between radiographic score and function-based knee pain (Neogi et al, 2009). Therefore, the association between radiographic score and knee pain requires further research.

The knee injury and osteoarthritis outcomes score (KOOS) is a valid self-reported questionnaire used to subjectively measure OA-related knee pain, function in daily life and sports/recreation activity, and quality of life in patients with knee OA (Seo et al, 2006).

Knee extensor or flexor weakness can induce muscle dysfunction, potentially leading to OA-related knee pain (Segal et al, 2009), and knee extensor strength is weakly associated with structural changes in knee cartilage, pain, and function in patients with knee OA (Baert et al, 2014). However, in a recent longitudinal study, strong knee extensors and flexors were asso-

ciated with less pain and improved daily living function in patients with knee OA, although neither knee extensor strength nor flexor strength were associated with structural damage as assessed using Kellgren-Lawrence scores (Luc-Harkey et al, 2018).

The evaluation of association between Kellgren-Lawrence scores and pain, function and muscle strength may give information for clinicians to guide decision-making, specifically estimating the radiographic severity based on level of pain, function and muscle strength in patients with knee OA. The purpose of this study was to examine the relationships between Kellgren-Lawrence scores and KOOS subscales including knee OA-related pain, daily living function, sports/recreation function, quality of life; and knee extensor and flexor strength in patients with knee OA. We hypothesized that Kellgren-Lawrence scores would be associated with pain, function, quality of life and muscle strength.

Methods

Subjects

We recruited 66 patients with unilateral knee OA

Table 1. Characteristics of patients with knee osteoarthritis (N=66)

Variables		
Age (years)		59.3±3.2 ^a
Body mass index (kg/m ²)		24.2±3.2
Grade of KL ^b score, N (%)	1	32(48)
	2	28(42)
	3	4(6)
	4	2(4)
Duration of knee pain (month)		38.6±26.6
KOOS ^c (range 0-100)	Knee pain	50.4±17.8
	Daily living function	53.8±16.9
	Sports recreation function	37.7±26.4
	Quality of life	37.4±21.1
Muscle strength (N/kg)	Knee extensor	2.7±1.2
	Knee flexor	1.2±.7

^amean±standard deviation, ^bKellgren-Lawrence, ^cknee injury and osteoarthritis outcome score.

(56 females, 10 males) from community health centers in Jeonju. The inclusion criteria were >50 years of age and radiographic confirmation of a tibiofemoral OA clinical diagnosis. Exclusion criteria were having received corticosteroid injections within the previous 3 months, oral corticosteroids within the past 1 month, a history of knee arthroplasty, uncontrolled hypertension, symptomatic coronary artery disease, and cognitive or neurological impairment (Henriksen et al, 2015).

The principal investigator explained all procedures to the participants, who then signed forms to indicate informed consent. This study was approved by the Institutional Review Board of Jeonju University.

Procedure

(1) Radiographic measurement of OA severity

OA severity was measured in subjects prior to participation. We first obtained weight-bearing posterior-anterior knee radiographs in standing and semi-flexed positions (Altman et al, 1986). A rheumatologist specializing in OA confirmed prior tibiofemoral OA clinical diagnosis and scored the subject’s severity of knee OA using the Kellgren-Lawrence scale (0: normal, 1: doubtful, 2: mild or minimal, 3: moderate, and 4: severe) based on the degree of osteophyte formation, joint space narrowing, and joint deformity.

(2) Measurement of knee pain, function and quality of life

Self-reported knee pain, daily living function, sports/recreation function, and quality of life were measured using KOOS scales. Scores ranged from 0

to 100, with 0 indicating severe knee problems and 100 indicating no knee problems. KOOS is known for its high validity and reliability (intraclass correlation coefficients [ICC]=.78-.97) in patients with OA (Roos and Toksvig-Larsen, 2003).

(3) Isometric measurement of knee extensor and flexor strength

A handheld dynamometer (Lafayette Instrument Company, Lafayette, IN, USA) was used to measure knee extensor and flexor strength by a physical therapist with 3 years of experience. The dynamometer has been shown to exhibit excellent reliability for knee extensor and flexor measurements in patients with knee OA (ICC=.75-.97) (Guillaume et al, 2016; Koblbauer et al, 2011). For familiarization, the tester performed measurements in two sub-maximal trials in each test position. After familiarization, two maximal isometric trials were performed during 5 s, with a 30 s rest between trials, and their average was used as the strength measurement. The knee extensor and flexor testing order was randomized. Strength was normalized as average strength (N) divided by body mass (kg).

Participants sat upright on an examination table with the legs hanging over the edge, hips and knees flexed to 90°, and hands resting on the thighs. The dynamometer was placed above the talotibial joint line on the anterior of the distal tibia to measure knee extensor strength, and above the lateral malleolus on the posterior part of the leg to measure knee flexor strength. Participants were asked to extend or flex the knee as hard as possible against the hand-

Table 2. Association between Kellgren-Lawrence radiographic scores and clinical data (N=66)

	KOOS ^a (range 0-100)				Muscle strength (N/kg)	
	Knee pain	Daily living function	Sports recreation function	Quality of life	Knee extensor	Knee flexor
Grade of KL ^b score ^c	-.49*	-.52*	-.46*	-.36*	-.41*	-.07

^aknee injury and osteoarthritis outcome score, ^bKellgren-Lawrence, ^cSpearman’s ρ value, *p<.05.

held dynamometer for 5 s (Guillaume et al, 2016).

Statistical Analysis

Age, weight, and height were recorded and body mass index was calculated (Table 1). Data were examined for normality using the Kolmogorov-Smirnov test. All dependent variables were normally distributed except Kellgren-Lawrence scores, so we calculated correlation coefficients between Kellgren-Lawrence score and KOOS score or muscle strength using Spearman's rank correlation test (good to excellent: $\geq .75$; moderate to good: $.50-.75$; fair: $.25-.50$; little or no relationship: $.00-.25$). The significance level was set at $.05$. All statistical analyses were performed using the SPSS ver. 18.0 software (SPSS Inc., Chicago, IL, USA).

Results

Kellgren-Lawrence scores were significantly correlated with KOOS scores for knee pain ($\rho = -.49$, $p < .01$), daily living function ($\rho = -.52$, $p < .01$), sports/recreation function ($\rho = -.46$, $p < .01$), and quality of life ($\rho = -.36$, $p < .01$). A significant negative correlation was found between Kellgren-Lawrence scores and knee extensor strength ($\rho = -.41$, $p < .01$) but not flexor strength ($\rho = -.07$, $p = .56$) (Table 2).

Discussion

We investigated the association between radiographic scores of OA severity and knee pain, function, quality of life, and strength in patients with knee OA. We found significant associations between Kellgren-Lawrence scores and knee pain, function, quality of life, and lower knee extensor strength in patients with knee OA.

Kellgren-Lawrence scores of knee OA indicate structural changes rather than pain severity (Bedson and Croft, 2008; Hannan et al, 2000). Therefore, it is

clinically important to investigate the association between radiographic scores and clinical signs, because OA diagnosis based on radiological scores without functional outcomes or clinical signs can result in overprescription of drugs and surgery among older patients. Previous studies have reported that Kellgren-Lawrence scores are not related to Western Ontario and McMaster universities osteoarthritis index scores for pain and function (Creamer et al, 2000; Cubukcu et al, 2012). However, we found that radiographic knee OA scores were significantly associated (fair or good to excellent) with self-reported KOOS pain and function subscales. Other studies have also reported a significant association between radiographic scores and knee pain (Ho-Pham et al, 2014; Neogi et al, 2009; Riddle and Jiranek, 2015), as found in our study.

Our results are consistent with a previous study that found that patients with knee OA 10-15 years after anterior cruciate ligament reconstruction had severe knee OA (Kellgren-Lawrence score 4). Regression analyses have shown that this condition is associated with greater pain, impaired function, and reduced quality of life as scored by KOOS subscales (Oiestad et al, 2011). Severe knee OA radiography scores are associated with radiographic features such as clear changes in bone, joint space narrowing, and cartilage changes (Oiestad et al, 2011). Although most participants in our study were diagnosed with mild to moderate knee OA (grades 1, 2, 3, and 4 of the Kellgren-Lawrence scale representing 48%, 42%, 6%, and 4% of subjects, respectively), radiographic scores were significantly associated with KOOS subscales. Thus, mild or moderate structural changes in represented in radiographic OA scores may also be correlated with clinical signs such as knee pain, function, and quality of life assessed as using the KOOS subscale. It is difficult to definitively conclude such an association due to limitations of the study. Future longitudinal studies are needed to confirm whether OA disease progression as revealed by radiography affects self-reported knee pain, function, and quality of life.

A moderate to good association has been reported between poor radiographic knee OA scores and low knee extensor strength; our results are in line with the results of a previous study (Omori et al, 2013). Another study demonstrated that severe OA indicated as by radiography and weak knee extensor strength play important roles in knee pain (Muraki et al, 2015). Knee extensor weakness leads to knee instability, which causes knee pain. Greater knee extensor strength is associated with lower risk of knee OA progression, suggesting that knee extensor strength is important in knee OA (Segal and Glass, 2011).

The knee flexor plays an important role in sitting, standing, and stair climbing; greater knee flexor strength is associated with more severe knee pain in patients with knee OA (Luc-Harkey et al, 2018). However, as found in our study, Luc-Harkey et al. (2018) demonstrated no significant association between Kellgren-Lawrence grade and knee flexor strength in patients with knee OA. Another study also reported that weak knee flexor strength was more closely linked to symptomatic knee OA progression than that assessed by radiography, because central sensitization or psychological components can influence weak hamstring muscle strength, which is not caused by the types of changes detected by radiography (Kemnitz et al, 2017).

This study had some limitations. First, it was a cross-sectional study, and therefore we could not identify causal relationships. Second, we recruited both 56 females and 10 males with knee OA. Although female have greater prevalence than male in previous large-scale study (4,733 patients with OA) (Plotnikoff et al, 2015), sex difference still can influence severity of knee OA, pain and function. Third, a relatively small number of participants had severe OA Kellgren-Lawrence score 3 and 4 (6% and 4%, respectively). Concurring our study, a previous study demonstrated relatively small number of participants with Kellgren-Lawrence score 3 and 4 (11% and 3%, respectively) (Culvenor et al, 2015). Future study would be needed to compare the differ-

ences of the knee OA-related pain, function and disability between sub-groups, classified by Kellgren-Lawrence grade or sex. Lastly, we measured only knee muscle strength. Previous studies have suggested that hip and ankle muscles such as the hip abductor and ankle plantar flexors also influence knee pain and function in patients with knee OA (Gonçalves et al, 2017; Tevald et al, 2016).

Conclusion

We examined associations between radiographic signs of knee OA and pain, function, quality of life and knee muscle strength in older patients with knee OA. We found that Kellgren-Lawrence scores were significantly associated with self-reported knee pain intensity, function in daily living and sports/recreation, quality of life, and knee extensor strength in patients with knee OA. Assessment of knee OA using self-reported KOOS and knee extensor strength may be a cost-effective alternative to radiological exams for patients with knee OA.

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