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ORIGINAL ARTICLE

Knee Pain and Radiographic Osteoarthritis Interact in the Prediction of Levels of Self-Reported Disability

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Objective. **To determine predictors of disability depending on whether joint deformity and pain reporting exist independently or concurrently.**

Methods. **Subjects were 154 volunteers for an osteoarthritis screening examination. Eligible subjects completed questionnaires for physical function, pain, and depressive symptoms; underwent evoked pain testing for tenderness assessment; and had anteroposterior and lateral radiographs taken of both knees. Two blinded rheumatologists scored the images using Kellgren-Lawrence criteria to determine presence of deformity.**

Results. **Subjects were divided into 3 subgroups based on radiographic evidence of deformity and self-reported pain. Disability was greatest when pain and deformity occurred together ($F[2,151] = 18.8$, $P < 0.0001$). Self-reported disability in the absence of deformity was predicted by body mass index, pain threshold, and anxiety symptoms; disability was predicted by the number of osteophytes and depressive symptoms when pain and deformity occurred together.**

Conclusion. **Self-reported disability in osteoarthritis of the knee is greatest with concurrent pain and joint deformity. When pain and deformity do not cooccur, disability appears to be related to separate factors, including anxiety and pain threshold (e.g., tenderness).**

KEY WORDS. Pain; Osteoarthritis; Disability.

INTRODUCTION

Self-reported disability is frequently associated with osteoarthritis (OA) of the knee (1). The primary clinical features of osteoarthritis (i.e., radiographic evidence of deformity and pain), however, imperfectly account for the degree of disability reported by patients (2). The objective of this article was to assess the relationship between disability and the defining features of OA of the knee (radiographic findings and pain) and to identify predictors of disability in patients where radiographic evidence of deformity and reports of pain occur differentially.

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SUBJECTS AND METHODS

Subjects. People between the ages of 50 and 80 years were recruited from the greater Washington, DC area through newspaper advertisements requesting volunteers for an arthritis screening study. An established diagnosis of OA was not a prerequisite, nor were overt signs or symptoms of knee disease. Individuals who responded to the advertisement were screened by a nurse practitioner and excluded from the study if they 1) had no radiographic evidence of deformity and concomitantly reported no pain or 2) had any chronic medical condition other than osteoarthritis known to be associated with disability (e.g., inflammatory rheumatic diseases, symptomatic cardiac or pulmonary disease, diagnosed mental illness, etc.).

Disability and functional status. The physical function section of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used as an indicator of self-reported disability (3). This section of the WOMAC evaluates 17 activities. Subjects rate the degree of difficulty experienced in the preceding 48 hours for each of the 17 activities using a 5-level numeric verbal descriptor scale (range 0–4). The activities included in the WOMAC physical function section occur commonly on a daily basis and have face validity for lower limb function. Higher scores indicate greater levels of difficulty (range 0–68).

Radiography. Weight-bearing anteroposterior and lateral radiographs were recorded of both semiflexed knees for each subject. Two rheumatologists, who were blinded to the clinical status of the subjects, scored the films using Kellgren-Lawrence criteria (K-L) (4). The K-L scoring used ratings from 0 to 4, where 0 = normal radiograph; 1 = doubtful pathology; 2 = minimal osteophytes, possible narrowing, cysts, and sclerosis; 3 = moderate, as in definite osteophytes with moderate joint space narrowing; and 4 = severe, with large osteophytes and definite joint space narrowing. The kappa statistic of agreement between the 2 raters was 0.6, indicating acceptable levels of agreement. Based on the K-L rating, participants were categorized into 2 groups: those with radiographic evidence of deformity (K-L $\geq$ 2) and those without evidence. In addition, the numbers of osteophytes identified in both knees were tallied, and joint widths were measured at the medial and lateral compartments of both knees to produce a measure of average joint width.

Pain. Pain was assessed using the pain section of the WOMAC (3). This measure of pain includes 5 summed items and is a commonly used indictor of OA knee pain. Based on the responses to this measure, subjects were categorized into 2 groups: those reporting pain (i.e., WOMAC pain $>$ 0) and those not reporting pain. In addition, tenderness to evoked pain, depressive symptoms, and anxiety symptoms were assessed. Tenderness was assessed by measuring experimental pain thresholds using an evoked pressure pain stimulus and following a method of limits. Stimuli were applied with a hand-held dolorimeter (Chatillon, Brooklyn, NY). Nine bilateral stimulation sites were used, including the medial fat pad of the knee (a typically low threshold site) and the anterior tibial region (a proximate high threshold site). Pain thresholds for both sites were averaged across the 2 sides of the body, producing an average pain threshold or measure of tenderness.

Mood was assessed using the Beck Depression Inventory (BDI) (5), a measure of depressive symptoms, and by the State-Trait Anxiety Inventory (STAI) (6), a measure of anxiety symptoms. Higher scores on both of these measures were indicative of greater symptomatology.

Demographics, morphometrics, and comorbid physical symptoms. The age and sex of subjects were recorded. Measures of weight (kilograms) and height (meters) were collected and used to calculate subjects' body mass index (BMI). A history and physical examination were performed by a nurse practitioner to exclude subjects with previously diagnosed conditions that could contribute to disability. The Systemic Complaints Questionnaire (SCQ) (7) was also administered to all subjects in the sample. The SCQ queries subjects about 47 symptoms commonly encountered in rheumatology practice that are associated with disorders of 11 systems and syndromes (i.e., neurologic, cardiac, gastrointenstinal, fatigue, etc.). Symptoms must have occurred in the past year. Symptoms associated with OA (e.g., morning stiffness, swollen joints) were not included in score calculations to avoid erroneous associations with the other measures of OA attributes.

Analysis. Subjects were categorized according to radiographic features (i.e., K-L positive evidence versus not) and upon pain complaints (i.e., pain versus no pain). A full factorial analysis of variance was used to determine the relative importance of radiographic features and pain complaints in determining self-reported disability.

To gain a better understanding of the factors that influence self-reported disability when radiographic evidence and pain are differentially present, correlations followed by backward regression modeling were used to predict disability using the following domains: 1) demographics, morphometrics, and comorbid physical symptoms (age, BMI, SCQ); 2) specific markers of deformity (osteophyte count, joint width space); and 3) pain components (pain threshold, BDI [depressed affect], STAI [anxious affect]). Correlations and regression models were repeated for each of the 3 groups defined in this study: participants with radiographically verified deformities but no pain, participants without radiographically verified deformities but reporting pain, and participants with both radiographically verified deformities and pain.

RESULTS

The sample consisted of 211 volunteers, 154 of which met the criteria of the study. The average age of the sample was 65.7 years (SD 9.1 years) and 66% were women. Table 1 identifies the characteristics of the 3 subgroups based on the presence or absence of radiographic findings and pain.

Determining self-reported disability from radiographic evidence and reported pain. Greater self-reported disability was found to be dependent on having both radiographically verified deformity and pain. This finding was supported by a significant interaction between the presence or absence of deformity and pain when determining self-reported disability ($F[2,151] = 18.8$, $P < 0.0001$).

Subgroup correlations and backward regression modeling. For each subgroup, correlations were established between self-reported disability and the previously stated variables of interest. Table 2 displays the correlation matrices for each subgroup.

For the subgroup demonstrating only radiographic evidence of deformity but reporting no pain, very low levels of disability were reported. The disability that was reported was marginally significantly and associated with

Table 1. Characteristics of the sample by subgroup

	Deformity only, no pain mean ± SD	No deformity, pain only mean ± SD	Both deformity and pain mean ± SD
Sample size, no.	16	79	59
Self-reported disability*	2.0 ± 2.9	12.94 ± 11.2	20.4 ± 12.5
Age, years	68 ± 6.0	64 ± 9.6	67 ± 8.6
Sex, no. M/F	11/5	22/57	20/39
Body mass index, kg/m^2	25.9 ± 3.0	26.1 ± 4.4	28.5 ± 5.5
Physical symptoms in past year†	0.6 ± 0.8	1.8 ± 2.0	1.4 ± 1.3
Kellgren-Lawrence rating‡	2.4 ± 0.6	0.5 ± 0.5	2.8 ± 0.9
Osteophyte count, total per joint	3.4 ± 2.3	0.4 ± 0.9	7.1 ± 3.7
Average joint space width, mm	4.5 ± 1.1	4.7 ± 1.0	3.8 ± 1.4
WOMAC pain scale	0.0 ± 0.0	4.3 ± 3.1	4.4 ± 3.5
Pain threshold§	3.3 ± 0.6	2.7 ± 0.8	2.7 ± 0.8
Depressive symptoms¶	3.8 ± 4.6	8.2 ± 7.0	7.7 ± 6.5
Anxiety symptoms#	25.7 ± 7.4	34.0 ± 10.6	32.7 ± 10.6

* Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) physical function score, range: 0–68, higher score = greater disability.
† Self report of systemic; rheumatologic symptoms, higher value = greater symptom reporting.
‡ Range 0–4, normal–severe pathology.
§ Minimum pressure (kg) applied to elicit pain of bilateral knee and anterior tibial regions.
¶ Beck Depression Inventory, range 0–63, higher score = greater severity.
# State-Trait Anxiety Inventory, range 20–80, higher score = greater severity.

greater BMI and higher osteophyte count. Backward regression modeling was not performed due to the small number of subjects in this group.

For the subgroup reporting pain in the absence of radiographic evidence of deformity, greater self-reported disability was significantly associated with greater BMI, greater self report of physical symptoms in the past year, lower pain threshold, and greater symptoms of both depression and anxiety. Using these predictors, backward regression modeling revealed a parsimonious model that retained predictors with t values of $P < 0.10$. This model accounted for 24% of the variance in disability ($F[3,69] = 7.30$, $P < 0.0001$), and included greater BMI, lower pain threshold, and greater anxiety symptoms (see Table 3).

For the subgroup having both pain and radiographic evidence of deformity, greater self-reported disability was significantly associated with a greater number of osteophytes and greater depressive symptoms. Backward regression modeling revealed a parsimonious model that accounted for 22% of the variance in disability ($F[2,56] = 8.0$, $P < 0.001$) that included both predictors (see Table 4).

DISCUSSION

The presence of radiographic evidence of knee deformity contributes to self-reported disability, but is dependent upon an interaction with coexisting complaints of pain. The combination of radiographically verified knee deformities and knee pain was associated with the highest levels of self-reported disability. The group with only pain and no deformities had moderate levels of disability rela-

Table 2. Correlations (r) between self-reported disability and measures of demographics, morphometrics, comorbid symptoms, radiographic markers, and pain by subgroup*

	Deformity only, no pain/disability	No deformity, pain only/disability	Both deformity and pain/disability
Age, years	0.05	0.20	−0.10
Body mass index	0.48	0.38	0.20
P	(0.062)	(<0.001)	
Physical symptoms in past year	0.23	0.22	0.17
P		(<0.05)	
Osteophyte count	0.48	−0.05	0.25
P	(0.06)		<0.05
Average joint space width	−0.38	0.00	−0.08
Pain threshold	0.20	−0.26	−0.18
P		(<0.01)	
Depressive symptoms	−0.20	0.32	0.38
P		(<0.01)	<0.01
Anxiety symptoms	0.02	0.30	0.23
P		(<0.01)	

* Significant correlations have *P* values indicated.

Table 3. Backward regression of predictors of self-reported disability for the subgroup with pain but no radiographic evidence of deformity*

R^2	F [3,69]	Variable	T	*P*
0.24	7.30			<0.001
		Body mass index	3.24	<0.002
		Pain threshold	−1.67	<0.099
		Anxiety symptoms	1.96	<0.054

* R^2 indicates percent variance accounted for by the statistical model. F statistic and associated *P* value indicate statistical significance of the model. T statistic and associated *P* value indicate whether each variable made a statistically significant contribution to the model.

tive to the group having only deformities and no pain. This latter group reported very little disability. In this study, the predictive value of more subtle factors, such as mood or tenderness, depended on the presence or absence of deformity and pain.

As stated, disability was highest when deformities and pain interacted. This study found both osteophyte count and the affective aspects of pain to play prominent roles in determining disability. This finding is encouraging because mood symptoms are amenable to intervention (8). Of particular interest was the subgroup with deformities that reported no pain. Although physical limitations were relatively low in this group, any disability that did exist was most strongly associated with verifiable deformity or morphometric characteristics. For the group without deformities but that reported pain, lower pain thresholds (tenderness) played a prominent role in determining reported disability. This group may be characterized by individuals who experienced pain in the absence of clear deformity but who concomitantly experienced heightened anxiety. For the group in whom both deformity and pain were present, depressive symptoms, rather than anxiety, were the strongest predictors of self-reported disability.

Table 4. Backward regression of predictors of self-reported disability for the subgroup with both radiographic evidence of deformity and pain*

R^2	F [2,56]	Variable	T	*P*
0.22	8.0			<0.001
		Depressive symptoms	3.48	<0.001
		Osteophyte count	2.37	<0.02

* R^2 indicates percent variance accounted for by the statistical model. F statistic and associated *P* value indicate statistical significance of the model. T statistic and associated *P* value indicate whether each variable made a statistically significant contribution to the model.

The implications of this study must be evaluated in light of the how the sample was recruited. Community samples recruited through an osteoarthritis screening program may not be representative of clinical populations. However, the objective of recruiting a heterogeneous group appeared to be met, allowing comparisons that highlighted the respective contributions of pain and radiographic changes to self-reported disability. Further replication of the results of this study in a clinical population would strengthen the implications of the findings.

The presence of pain in osteoarthritis of the knees appears to be the single most important factor in shaping perceptions of disability. Evidence of physical change in the osteoarthritic knee, notably osteophytosis, is also associated with disability but to a much lesser extent. Depressive symptoms, anxiety, lowered pain threshold, and BMI also appear to play important roles in determining disability for subgroups of individuals. Modifying one or several of these variables that impact pain has considerable potential for improving functional difficulties among patients with osteoarthritis of the knee.

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