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Research Article

Is There a Correlation Between the Clinical, Radiological and Ultra-Sonographic Findings of Osteoarthritis of the Knee?

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ABSTRACT

Objectives: The association between the severity of knee pain and the clinical and radiological findings can help to assess the severity of knee osteoarthritis. The present study aimed to assess the relationship between knee pain severity and clinical, radiological and ultra-sonographic findings in patients with knee osteoarthritis. Methods: We recruited 52 patients with primary osteoarthritis. Physical examination and ultrasonography were done. Plain radiography was done within 3 weeks of clinical examination. Results: The average age of participants was 59.27 ± 9.85 years. Using multivariable linear regression modeling, pain severity had no significant association with any of the covariates including epidemiological, clinical and ultrasound findings. The severity of clinical symptoms and stiffness was associated with the ultrasound finding of Baker's cyst as well as with tenderness of internal compartment and suprapatellar effusion. In addition, the level of daily function remained to be associated with baker's cyst in ultrasound assessment as well as with tenderness of internal compartment. Conclusion: Our study showed no association between ultra-sonographic, clinical or radiological findings and the level of knee pain; however, knee function, disability, and the level of quality of life are associated with some clinical and ultrasound evidences of knee osteoarthritis.

Keywords: knee, osteoarthritis, ultrasound, x-ray.

INTRODUCTION

About half of the older individuals suffer from knee pain that half of those have radiological evidences of knee osteoarthritis[1]. Demographically, knee osteoarthritis is more frequent in women than in men and its overall prevalence is closely associated with some potential risk factors including advanced age, obesity, knee surgical interventions, knee trauma, and hormonal defects especially in menopausal women[2,3]. In spite of scheduling proper preventive programs as well as improvement of lifestyle, the development of knee osteoarthritis may lead to progressive daily disability and lowering quality of life[4,5]. The level of pain and severity of disability is significantly higher in women and in fact knee osteoarthritis can be symptomatic with prominent radiological features more in women[6]. The major diagnostic challenge of knee osteoarthritis is its important differential diagnoses particularly in the presence of soft tissue involvement such as bursitis, ligamentous instability, meniscal changes, neuropathy or radiculopathy, avascular necrosis, and even malignancies[7]. In this regard, the American College of Rheumatology has introduced definitive clinical, laboratory, and radiological criteria for diagnosis of knee osteoarthritis with a high diagnostic sensitivity (ranged 91 to 95%) and an appropriate specificity (ranged 69 to 86%)[8,9]. In this criteria, the presence of pain as clinical and the presence of osteophytes as radiological hallmarks are essential for confirming diagnosis of knee osteoarthritis. In total, a combination of clinical and imaging evidences is useful to achieve ultimate diagnosis of disease[10]. Recently, standard plain radiography is the primary imaging modality used to evaluate primary knee osteoarthritis indicating bony abnormalities and indirect signs of articular cartilage lesions[11]. Although this modality is available and partially affordable, some potential limitations such as its inability to directly visualize articular cartilage, synovial recesses, menisci and other soft tissues involvements have been also considered[12]. High-frequency ultrasonography is a supplement diagnostic tool with high capability to assess

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intra-articular and peri-articular pathologies occurred in knee osteoarthritis[13].

According to this fact that the presence of pain is the most devastating symptom of patients with knee osteoarthritis, the association between the severity of knee pain and the clinical and radiological findings can help to assess the severity of knee osteoarthritis and also its prognostic feature. Some studies could show that perceived pain by the patient was not directly associated with clinical and radiographic findings[14]; however, some clinical, radiological and ultrasound findings have been also shown to be of worth in predicting pain and its severity in patients with knee osteoarthritis[15]. Hence, the present study aimed to assess the relationship between knee pain severity and clinical, radiological, and ultrasound findings in patients with knee osteoarthritis.

MATERIALS AND METHODS

Within the framework of a cross-sectional study, we recruited 52 patients (sample-size calculated based on the adapted formula for comparing two means) with primary knee osteoarthritis, which fulfilled the criteria of American College of Rheumatology. Before entrance, all parts of the study were explained for the patients and they all signed an informed consent. The exclusion criteria of the study were secondary osteoarthritis, receiving corticosteroid or hyaluronic acid injection in their Knees in the last three months, or undergoing knee joint replacement. Epidemiologic information and lab data of patients including age, gender, weight, height, duration of the disease, history of cigarette smoking, and history of osteoporosis or menopause, as well as level of vitamin D were gathered through a questionnaire from patients and hospital recorded files. Physical examination was done by a fellowship of rheumatology and following pathologies including presence of warmth, erythema, effusion, deformity, crepitating, Baker's cyst or anserine bursitis, and also limitation in passive or active movement were also recorded. Radiography in two views were done within 3 weeks of clinical examination in two anterior-posterior and lateral views and graphs were further read and classifies based on grading, defined by Kellgren and Lawrence in 1963. In this regard, the changes are graded by a radiologist as: 0 (none) indicates no features; 1 (doubtful) indicates minute osteophyte, doubtful significance; 2 (minimal changes) indicates definite osteophyte and unimpaired joint space; 3 (moderate changes) indicates moderate diminution of joint space; and 4 (severe changes) indicates Joint space greatly impaired with sclerosis of subchondral bone. Ultrasound was done by a rheumatologist who was expert in musculoskeletal sonography at the same day, as physical examination has been done. Ultrasonography was done with a 13 MHz's linear Probe (Sonosite Ò, Canada) in at least three separated compartments. Operating attending was blinded to the results of radiographic as well as clinical findings. Following pathologies were diagnosed and charted in ultrasonography: Protrusion of medial and lateral meniscus, Meniscal Degeneration, suprapatellar as well as medial and lateral compartment Effusion, suprapatellar as well as lateral and medial compartment Synovial Hypertrophy, marginal osteophytes, Baker's Cyst, anserine bursitis, and thickness of the cartilaginous column of the medial and intercondylar region of tibio-femoral joint was also measured and gathered. Subjective pain-perception of patients was asked through Visual Analogue Score for pain on a scale from 1 to 100. Subjective pain-perception as well as self-reported physical disability was asked via a validated translated (Persian) WOMAC score.

Statistical analysis

All data entered the commercially available statistical software (SPSS version 18.0). Descriptive analyses were done for all data, and frequency for qualitative variables and mean and standard deviation for quantitative variables were reported. The association between different pathologies and different entities of WOMAC score as well as VAS score was sought, using one sample t-Test or Mann-Whitney U test. The association between different grades of Radiological scoring and pain scores was assessed using ANOVA test or non-parametric Kruskal Wallis H test. In order to eliminate the effect of confounding variables, all covariates that were associated with pain scores entered the final linear regression model. P value< 0.05 was considered to be significant. By linear regression model, because of multiple comparisons and combined analyses, P<0.01 (accepted an error error<0.01) was acceptable.

RESULTS

Baseline information

In this cross-sectional study, 52 patients with primary knee osteoarthritis were included. The average age of participants was 59.27± 9.85 years and 84.3% were female. The mean disease duration was 70.68±56.4 months. The mean body weight was 76 ± 18.9 kg and the mean body mass index was also 33.92± 29.4 kg/m^2. In total, 15.7% of subjects were smoker. Bone densitometry analysis showed osteopenia in 19.6% and osteoporosis in 7.8% of cases with a mean overall serum vitamin D level of 27.19± 20.47 ng/dl. Regarding the pain severity status according to VAS score, the mean VAS at rest was 35±2.9 that increased to 70.5±2.64 in activity state. The mean scores for different components of pain-perception as well as self-reported physical disability based on the WOMAC scaling are shown in Table 1. With respect to radiological grading of knee osteoarthritis, 4.8% of patients were graded as 0, 31.0% graded as 1, 33.3% graded as 2, 23.8% graded as 3, and 5.9% graded as 4. Osteophyte and joint space narrowing was detected in 28 (64.3%) and 11 (25.5%) patients respectively. As show in figure 1, the most frequent clinical manifestation included crepitation (92.2%) following by restriction of flexion (25.5%), tenderness of internal compartment (25.5%), and bony overgrowth (21.6%). Also, as presented in figure 2, the main findings in ultra-sonographic assessment were osteophytes in 78.4%, medial meniscus protrusion (72.5%), meniscal degeneration (70.8%), and lateral meniscus protrusion (52.1%).

Univariate association results

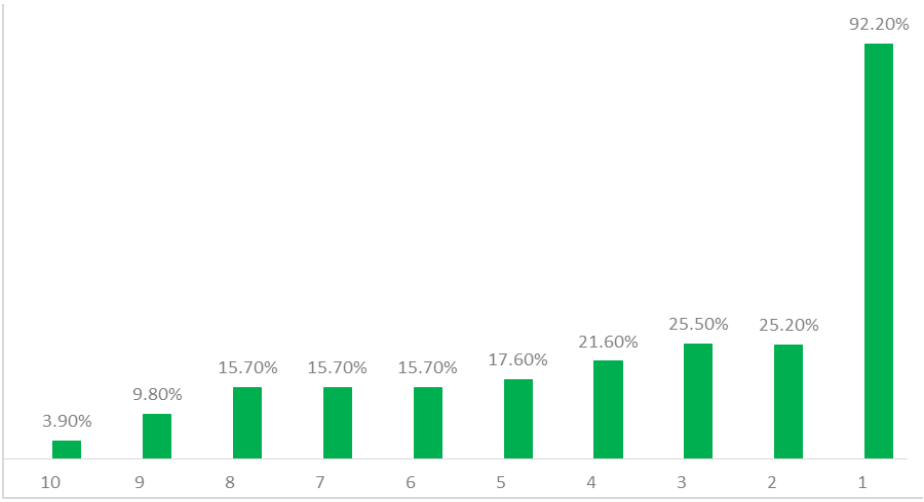

Figure 1: Frequency of Clinical Findings
1: Crepitation; 2: Restriction of Flexion; 3: Tenderness of Internal Compartment; 4: Boney Enlargement; 5: Tenderness of External Compartment, 6: Deformity; 7: Restriction of Extension; 8: Inserine Tendinitis; 9: Effusion; 10 Baker's Cyst.

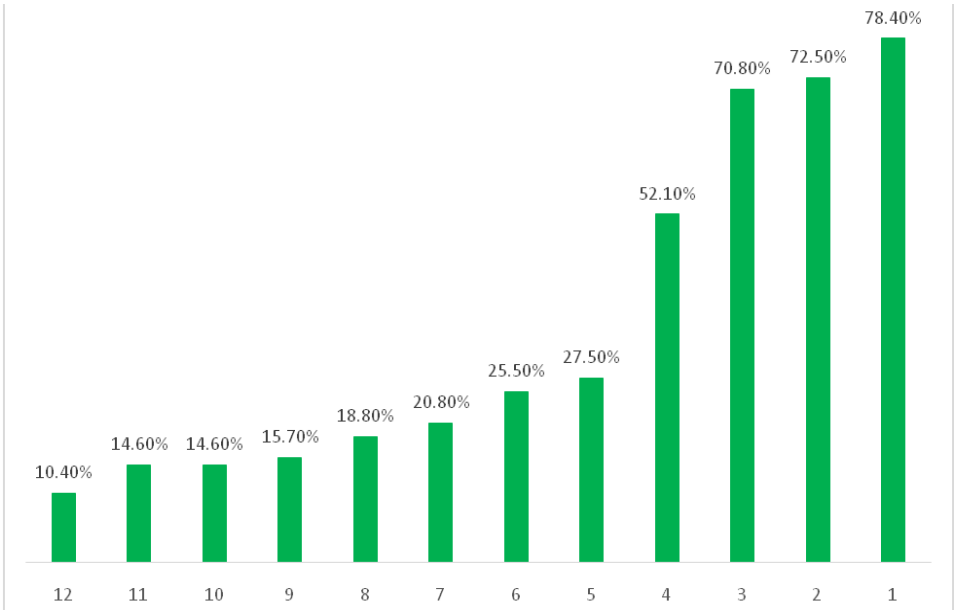

Figure 2: Frequency of Sonographic Findings.
1: Osteophytes; 2: Medial Meniscal Protrusion; 3: Meniscal Degeneration; 4: Lateral Meniscal Protrusion; 5: Suprapatellar Effusion; 6: Suprapatellar Synovial Hypertrophy; 7: Lateral Compartment Effusion; 8: Baker's Cyst; 9: Inserine Tendinitis; 10: Lateral Compartment Synovial Hypertrophy; 11: Medial Compartment Effusion; 12: Medial Compartment Synovial Hypertrophy

Assessing correlation between clinical findings and pain severity scores (Table 2) showed an association between VAS in activity and symptoms including restriction of flexion, anserine bursitis, and tenderness of both internal and external compartments. In this regard, pain severity assessed by WOMAC score was positively associated with two symptoms of restriction of flexion and tenderness of external compartment. The severity of symptoms and stiffness was significantly related to the symptoms of anserine bursitis, tenderness of both internal and external compartments, and Baker's cyst. Daily activity and function (according to the WOMAC score) reduced more in those patients with the manifestations of anserine bursitis and tenderness of internal compartment. Also, sport and exercise ability was limited in those with the manifestations of crepitation, deformity, and tenderness of internal compartment. Similarly, the level of quality of life reduced more in those with crepitation and deformity.) Assessing the agreement of pain and disability with ultra-sonographic finding (Table 3) showed an association between pain severity during activity based on VAS score and medial compartment synovial hypertrophy. Also, pain severity according to WOMAC score was related to meniscal degeneration. The severity of stiffness was significantly related to some findings including suprapatellar effusion, lateral meniscus

Table 1: Pain and disability score in study population with knee osteoarthritis.

Pain Score	Mean ± SD
VAS in Rest	35±2.9
VAS in Activity	70.5±2.64
WOMAC (Pain)	62.15±9.29
WOMAC (Symptoms and Stiffness)	42.53±23.93
WOMAC (Daily Activity and Function)	49.79±17.98
WOMAC (Sport and Exercise)	79.41± 7.87
WOMAC (Quality of Life)	36.87± 20.56

protrusion, meniscal degeneration, and medial compartment synovial hypertrophy, and Baker's cyst. Limitation in daily activity and function was significantly higher in those with the ultra-sonographic findings of meniscal degeneration and baker's cyst. Also, sport and exercise were significantly limited in those with meniscal degeneration. Moreover, the level of quality of life reduced more in those patients with baker's cyst.

Multivariate association findings

Using multivariable linear regression modeling, VAS score in activity had no significant association with any of the covariates including epidemiological, clinical and ultra-sonographic findings. Also, in this model, pain severity based on WOMAC score was slightly associated with meniscal degeneration (beta = 2.83, p-value = 0.092). Multivariable regression analysis also revealed that ability to exercise was only associated with tenderness of the internal compartment (beta = 0.288, p-value = 0.037), and crepitation (beta = 0.327, p-value = 0.017). In this model, the level of quality of live was slightly associated with crepitation (beta = 0.357, p-value = 0.054) and deformity (beta = 0.248, p-value = 0.064).)

The application of multivariate analysis showed that the severity of clinical symptoms and stiffness was associated with the ultrasound finding of baker's cyst (beta = 0.281, p-value = 0.050) as well as with tenderness of internal compartment (beta = 0.281, p-value = 0.002) and suprapatellar effusion (beta = 1.96, p-value = 0.057). In addition, similar multivariate regression model showed that the level of function based on WOMAC score remained to be associated with baker's cyst in ultrasound assessment (beta = 0.328, p-value = 0.044) as well as with tenderness of internal compartment (beta = 0.347, p-value = 0.019).

Comparison between plain radiograph and ultrasound showed that ultrasound was more sensitive than plain radiograph in detecting osteophyte (p-value = 0.008).

Cartilage thickness (either inter-condylar or medial compartment) measured by ultrasound did not differ significantly between patients with and without radiologic joint space narrowing (p-value = 0.677 & 0.658 respectively)

Also, ultrasound was more sensitive than physical examination in detecting joint effusion and baker cyst (p-value = 0.024 & 0.003 respectively).

There was not any significant difference between anserine bursitis detection by ultrasound or physical examination (p-value = 0.07)

DISCUSSION

The first important point of the current study was that none of the demographic variables were associated with the applied pain scores including VAS and WOMAC pain scores. In other words, knee pain severity has not been identified as a good marker for appearing clinical manifestations or sonography hallmarks. The similar studies led to conflicting results. In a study by de Miguel Mendieta in 2006, suprapatellar effusion, Baker's cyst as the sonography findings and body mass index as a clinical parameter were the factors associated with the appearance of pain after the logistic regression analysis and therefore those have been shown as risk factors of painful flare in knee osteoarthritis[16]. In another study by Naredo et al in 2005, ultra-sonographic effusion, protrusion of the medial meniscus and displacement of the medial collateral ligament were associated with a significantly higher VAS score for pain[17]. De Miguel et al. found an association between Baker's cyst and suprapatellar effusion and VAS pain in motion when comparing patients with pain and without pain, but they found no association with the severity of pain[16]. However, similar to our results, Bevers et al in 2014, showed no association between ultra-sonographic or clinical or demographic features and the level of knee pain[18]. In total, we were unable to demonstrate any explanation based on ultra-sonographic findings for the level of knee pain. D'Agostino et al. also found an association between joint effusion and sudden aggravation of knee pain, but again no association between ultra-sonographic inflammatory signs and pain during activity[19]. Some previous ultra-sonographic studies in knee OA do show associations between US features and pain, but only when comparing patients with and without pain. In these studies, two aspects stand out: first, they include a control group of patients without pain, which enhances contrast, and second, there is wide variation in the ultra-sonographic features that show an association with pain and in the pain measure that is used, with consistent replication of the findings being absent. Variables that have been found to be associated with the presence of pain include medial compartment synovitis[20], quadriceps tendon thickness[21], Baker's cyst and supra patellar effusion[16]. Also, the pain measures used vary from pain expressed as VAS pain at rest, medial knee pain and VAS pain in motion. However, although the studied US items often overlap, associations found can often not be replicated. Thus far, in line with our findings, no single US finding has been consistently linked to the level of pain in knee osteoarthritis. Divergence between different studies could be partially attributed to different definitions of pathologies. Moreover, ultrasonography is now and again an operator–dependent modality. Standardization the protocols of US-operation could be helpful in making the results comparable.

Despite no association between pain severity and clinical and imaging evidences, some clinical components and sonographic parameters were shown to be associated with functional impairment, stiffness, disability, and lowering

Table 2: The relation between pain and disability score and clinical findings.

	ROE	ROF	CREP	EFF	SH	DEFORM	AB	TIC	TEC	BC
VAS activity	0.78	0.02	0.17	0.08	0.97	0.77	0.01	0.01	0.04	0.44
VAS in rest	0.23	0.06	0.06	0.34	0.65	0.12	0.26	0.07	0.71	0.06
WOMAC 1	0.31	0.03	0.54	0.12	0.34	0.45	0.13	0.06	0.03	0.98
WOMAC 2	0.13	0.98	0.13	0.55	0.67	0.08	0.02	< 0.01	0.01	0.04
WOMAC 3	0.65	0.87	0.44	0.30	0.34	0.69	0.04	0.01	0.06	0.29
WOMAC 4	0.93	0.12	0.02	0.56	0.07	0.02	0.61	0.02	0.09	0.54
WOMAC 5	0.21	0.30	< 0.01	0.47	0.54	0.02	0.09	0.86	0.12	0.06

ROE: restriction of extension, ROF: restriction of flexion, EFF: effusion, SH: Synovial Hypertrophy, DEFORM: deformity, AB: anserine bursitis, TIC: tenderness of medial compartment, TEC: tenderness of external compartment, BC: baker's cyst.

Table 3: The relation between pain and disability score and ultrasound findings.

	OST	SPS	SPE	MMP	LMP	MD	MCS	LCS	MCE	LCE	BC	AB
VAS activity	0.06	0.09	0.60	0.07	0.07	0.17	0.04	0.19	0.10	0.55	0.09	0.20
VAS in rest	0.10	0.12	0.06	0.06	0.55	0.10	0.26	0.06	0.18	0.89	0.17	0.08
WOMAC 1	0.97	0.45	0.10	0.20	0.34	0.04	0.13	0.60	0.53	0.08	0.99	0.71
WOMAC 2	0.07	0.06	0.03	0.06	0.01	0.04	0.04	0.89	0.34	0.18	< 0.01	0.20
WOMAC 3	0.21	0.34	0.07	0.30	0.14	0.01	0.09	0.15	0.93	0.07	< 0.01	0.17
WOMAC 4	0.08	0.68	0.09	0.16	0.93	0.02	0.61	0.06	0.09	0.07	0.20	0.66
WOMAC 5	0.19	0.54	0.77	0.08	0.06	0.09	0.09	0.06	0.06	0.96	0.03	0.11

OST: osteophytes, SPS:suprapatellar synovitis, SPE: suprapatellar effusion, MMP: medial meniscus protrusion, LMP: lateral meniscus protrusion, MD: meniscal degeneration, MCS: medial compartment synovitis, LCS:lateral compartment synovitis, MCE: medial compartment effusion, LCE: lateral compartment effusion, BC: Baker's cyst, AB : anserine bursitis.

quality of life level. In this regard, the major finding was that exercise disability was mainly induced by tenderness of the internal compartment and crepitation. Also, those with crepitation and deformity had lower quality of life level. Also, joint stiffness was more observed in those patients with the sonographic evidences of Baker's cyst, tenderness of internal compartment, and suprapatellar effusion. Moreover, daily dysfunction was more revealed in those with Baker's cyst and tenderness of internal compartment in sonography assessment. In fact, the tenderness of medial compartment, crepitation, and deformity of the joints were three findings that correlated with different parts of WOMAC function and disability scoring, but this finding has not been emphasized in other studies. The quality of life consists of different physical and psychological components. The main physical aspects of quality of life are potentially affected by physical disability that can be induced by progression of knee stiffness and joint dysfunction explaining the significant association between both clinical and imaging findings and WOMAC function and disability components.

CONCLUSION

Our study showed no association between ultra-sonographic, clinical or demographic features and the level of knee pain; however, knee function, disability, and the level of quality of life are associated with some clinical and sonographic evidences of knee osteoarthritis.

CONFLICT OF INTEREST

None declare

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