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Original Article

# Correlation between functional score, radiographic and ultrasonographic findings in patients with osteoarthritic knee: A cross-sectional study

Shabeeba Sherin[1], Osama Neyaz[2], Raj Kumar Yadav[1], Sonal Saran[1]

[1]Department of Physical Medicine and Rehabilitation, All India Institute of Medical Sciences, Rishikesh, Rishikesh, India
[2]Department of Physical Medicine and Rehabilitation, King George's Medical University, Lucknow, Lucknow, India

## Abstract

**Objectives:** This study aims to evaluate the correlations between pain, dysfunction, musculoskeletal ultrasound (US), and radiological findings in patients with bilateral osteoarthritis (OA) knee.

**Patients and methods:** This prospective, cross-sectional study included a total of 130 patients aged >40 years with bilateral OA knee and no history of trauma, inflammatory, or infective conditions of the knee, intraarticular interventions, and surgery between April 2021 and August 2022. Knee pain and dysfunction were assessed using the Visual Analog Scale (VAS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Musculoskeletal US evaluation (osteophytes, articular cartilage thickness, medial meniscal protrusion, Baker's cyst, synovial hypertrophy, and effusion) and radiological assessment with Kellgren-Lawrence (K-L) grading were performed.

**Results:** Of a total of 130 patients, 100 were female and 30 were male with a mean age of 55.2±8.4 (range, 41 to 78) years. The mean VAS score was 7.3±1.3 and the mean WOMAC score was 74.36±11.67. Both VAS and WOMAC scores increased with the severity of radiological findings (K-L grading) ($p<0.001$). The presence of osteophytes, articular cartilage thickness, and medial meniscal protrusion at musculoskeletal US examination was strongly and positively correlated with K-L grading ($p<0.001$) and also with VAS score and WOMAC score ($p<0.001$).

**Conclusion:** Our study results indicate a positive correlation between pain, dysfunction, musculoskeletal US, and radiological findings in patients with bilateral knee OA. These findings suggest that musculoskeletal US may provide valuable complementary data to conventional radiography in evaluating pain-related structural pathology in knee OA.

***Keywords:*** Dysfunction, knee pain, musculoskeletal ultrasound, osteoarthritis knee.

Osteoarthritis (OA) is a disorder involving movable joints characterized by cell stress and extracellular matrix degradation initiated by micro- and macro-injury which activates maladaptive repair responses, including pro-inflammatory pathways of innate immunity. The disease manifests first as a molecular derangement (abnormal joint tissue metabolism), followed

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**Correspondence:** Osama Neyaz. Department of Physical Medicine and Rehabilitation, King George's Medical University, Lucknow (U.P.), 226003 India.

**E-mail:** osamaneyaz@gmail.com

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by anatomic and/or physiologic derangements (characterized by cartilage degradation, bone remodeling, osteophyte formation, joint inflammation and loss of normal joint function) which can culminate in illness.[1] Osteoarthritis most commonly affects the knee joint, although it can also affect the hands, feet, spine, and other weight-bearing joints.[2,3]

The prevalence of OA knee in India is 28.7%, with a more significant occurrence in elderly, sedentary individuals, females, and those with obesity.[4] It is one of the most common causes of pain and disability, with significant health, economic, and social burden.[5] Osteoarthritis can be diagnosed clinically, but imaging, most commonly radiography, helps identify the joint structure involved and also in treatment planning for prognosis and follow-up.

Both magnetic resonance imaging (MRI) and musculoskeletal ultrasound (US) allow imaging of various features relevant to OA, including osteophytes, effusions, synovitis, enthesitis, bursitis, and cartilage pathology. However, MRI's high cost and unavailability make it unsuitable for routine clinical practice. Furthermore, MRI is not feasible in frequent clinical scenarios, such as for those with claustrophobia, a bigger body habitus, or metal implants.[6] High-frequency musculoskeletal US is a frequently used, non-invasive imaging technology that does not expose users to radiation, with the extra benefits of portability, real-time dynamic examination, and lower cost.[7,8]

To date, several recent studies have investigated whether there are any associations between musculoskeletal US findings and symptoms in patients with OA knee. A few recent studies have also shown correlations. However, no definitive conclusions were reached. Most of the authors emphasized the need for additional research in this area.[9-13] In the present study, we aimed to evaluate the correlation between knee pain and dysfunction with a plain radiograph and musculoskeletal US findings in individuals with OA knee.

## PATIENTS AND METHODS

This single-center, prospective, cross-sectional study was conducted at All India Institute of Medical Sciences, Department of Physical Medicine and Rehabilitation (PMR) between April 2021 and August 2022. A total of 130 individuals aged >40 years visiting the PMR outpatient clinic with complaints of bilateral knee pain, fulfilling the 2019 American College of Rheumatology (ACR) criteria for OA knee were included. Patients with inflammatory arthritis, intra-articular neoplasm, osteonecrosis, neuropathy, fibromyalgia, previous history of trauma, knee surgery, and intra-articular intervention in the preceding six months were excluded from the study. Demographic and clinical data of the patients were retrieved from the hospital database. A written informed consent was obtained from each participant. The study protocol was approved by the All India Institute of Medical Sciences, Rishikesh Ethics Committee (Date: 11.06.2021, Approval no: 246/IEC/PGM/2021). The study was conducted in accordance with the principles of the Declaration of Helsinki.

### Study protocol

A thorough history-taking and clinical examination of the patients was conducted to exclude secondary causes of OA knee during the clinical evaluation of all patients. All patients were evaluated for pain using a Visual Analog Scale (VAS), 0–100 mm, and knee functioning using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores. The patient's more symptomatic knee was considered for the study.

Plain radiographic knee examinations (X-ray) were performed in all patients in two views, anteroposterior (AP) with load and lateral. Classification of OA knee severity was performed using the Kellgren-Lawrence (K-L) scores. The same radiologist analyzed all X-ray exams. Musculoskeletal US examinations were performed by a single physiatrist with a nine-year experience in the field of musculoskeletal US. These examinations were done using a 7 to 13 MHz linear probe, My Lab One US device (model 8100, Esaote, Japan). First, the patients were evaluated for osteophyte size, protrusion of medial meniscus (MMP), effusion in the joint and synovial hypertrophy. The patients were asked to

lie supine with knees flexed to 20 to 30 degrees while keeping a pillow under the knee.

First, we checked for osteophytes, as shown in Figure 1 (Appearance of osteophytes in the musculoskeletal US of OA knee). Osteophytes are graded using a scale validated by Mortada et al.[14]

- Grade 0- No osteophytes; regular end of femoral condyle without any projections.
- Grade 1- Minor osteophytes, just a small projection from the femoral condyle.
- Grade 2A- Small osteophyte, moderate level projection.
- Grade 2B- Large osteophytes appear to be separated from the femoral condyle and have an inferior part in the joint space zone.
- Grade 3- Large osteophyte appears to be separated from the femoral condyle and to have an inferior part in the joint space zone with a small superior extension parallel to the femoral bone.
- Grade 4- Mainly superior osteophyte parallel to the femoral bone with or without an inferior part in the joint space zone.

Then, we checked for MMP, as shown in Figure 2 (Appearance of medial meniscus protrusion in the musculoskeletal US of OA knee). It was considered the perpendicular distance between the outer meniscus margin and the joint line through the longitudinal scan.[13]

Patients were evaluated for joint effusion and synovial hypertrophy in the same position as shown in Figure 3 (Appearance of synovial effusion in US of OA knee). These two findings (joint effusion and hypertrophy of synovium) were graded on a four-point scale:[10] 0=normal, 1 = from 0 to 3 mm, 2 = from 3 to 7 mm, 3 = from 7 to 11 mm, and 4 = ≥11 mm.

- Then, subjects were examined for the thickness of femoral hyaline cartilage, for which the knee was kept in maximum flexion, as shown in Figure 4 (Appearance of tibiofemoral cartilage in US of OA knee). In a transverse plane, the femoral hyaline cartilage was assessed and classified in 5 degrees:[15] 0 = normal, 1 = loss of regular contour level interfaces or increased echogenicity of cartilage, 2A = modification from degree 1 with a decrease in the thickness of the cartilage 50%, but under

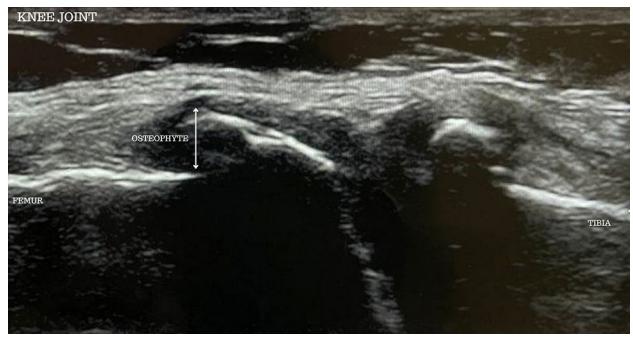


**Figure 1.** Appearance of osteophytes in the musculoskeletal ultrasound of osteoarthritis knee.

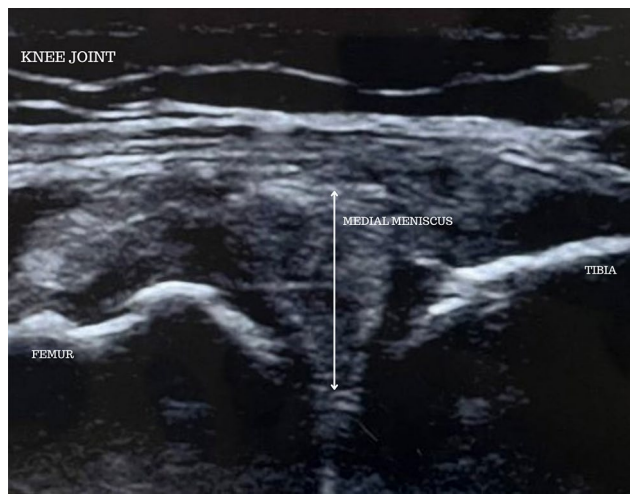


**Figure 2.** Appearance of medial meniscus protrusion in the musculoskeletal ultrasound of osteoarthritis knee.

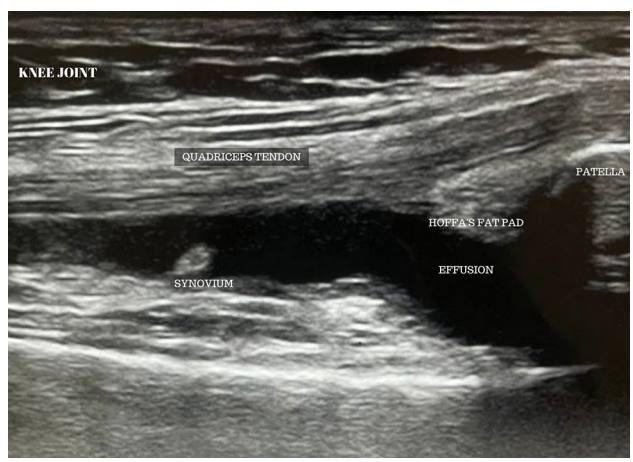


**Figure 3.** Appearance of synovial effusion in musculoskeletal ultrasound of osteoarthritis knee.

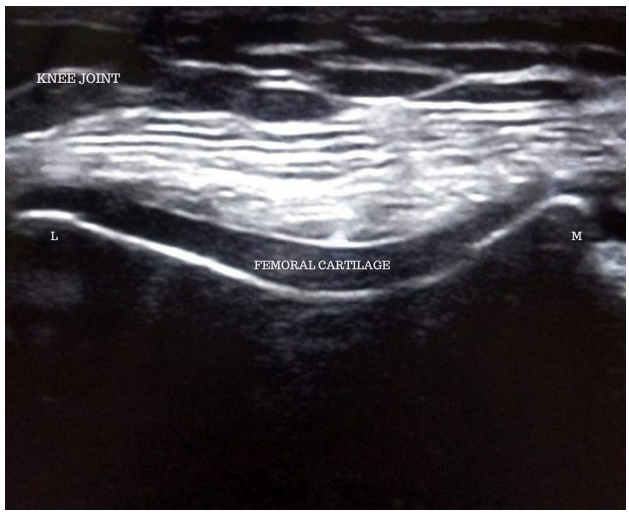


**Figure 4.** Appearance of tibiofemoral cartilage in musculoskeletal ultrasound of osteoarthritis knee.

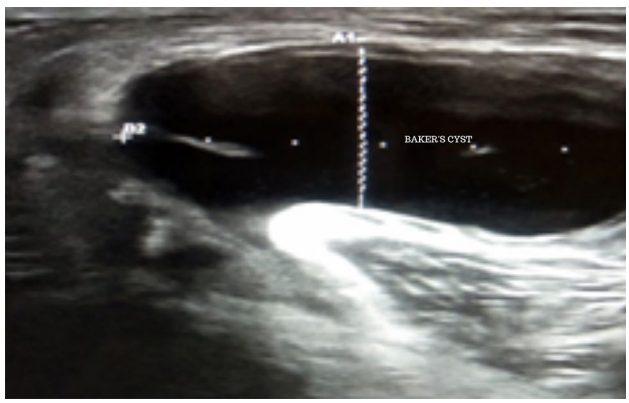


**Figure 5.** Appearance of Baker's cyst in musculoskeletal ultrasound of osteoarthritis knee.

100%, 2B = degenerative changes with local thinning of the cartilage more than 50% but less than 100%, 3 = 100% focal loss of cartilage thickness.

The posterior side of the knee joint was scanned in longitudinal and transverse planes while the patient was asked to lie prone, as shown in Figure 5 (Appearance of Baker's cyst in US of OA knee).

### Statistical analysis

Statistical analysis was performed using the IBM SPSS version 23.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were presented in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. The Shapiro-Wilk test was used to check the normality of continuous data such as age, height, weight, body mass index (BMI), VAS and WOMAC scores. The Kruskal-Wallis test was used to evaluate the difference between pain scales (VAS and WOMAC) classified by musculoskeletal US findings. The Wilcoxon-Mann-Whitney U test was used for the comparison of musculoskeletal US findings. The Kendall Tau-b Correlation coefficient *(Tau)* and Point Biserial correlation coefficient $(r^2)$ were used to find the correlations between VAS and WOMAC. and the musculoskeletal US and radiological findings. A $p$ value of $<0.05$ was considered statistically significant.

## RESULTS

Of a total of 130 patients, 100 were female and 30 were male with a mean age of 55.2 ± 8.4 (range, 41 to 78) years. The demographic features of the subjects are presented in Table 1. Most of the patients had Grade 4 K-L scores on radiological examination.

The presence of MMP, large osteophytes and focal loss of cartilage thickness were the most predominant musculoskeletal US findings. WOMAC and VAS scores increased with the severity of X-ray and musculoskeletal US findings of OA knee, as shown in Table 2a (radiological and few US findings with corresponding average VAS and WOMAC score) and Table 2b (other US findings with corresponding average VAS and WOMAC score).

The presence of osteophytes and loss of articular cartilage thickness on musculoskeletal US examination was strongly correlated with radiological K-L score, with a correlation coefficient of 0.55 and 0.61, respectively. Synovial hypertrophy and MMP were correlated moderately with K-L grades (0.32 and 0.40). Synovial effusion and a baker's cyst correlate poorly with K-L grades. The intensity of pain assessed by the VAS score strongly correlated with US-detected osteophytes (0.51), and the pain and dysfunction assessed by the WOMAC scale were moderately correlated. The severity of loss of cartilage damage and presence of MMP showed strong correlation, and synovial effusion showed moderate correlation, while the presence of Baker's cyst showed poor correlation

**Table 1. Demographic features of the study population (n = 130)**

| | n | % | Mean ± SD | Range |
|---|---|---|---|---|
| Age (year) | | | 52.2 ± 8.4 | 41–78 |
| Sex<br>Male<br>Female | <br>30<br>100 | | | |
| BMI (kg/m²) | | | 28.4 ± 4.4 | 19.7–42.2 |
| Laterality of symptoms on left side | 92 | 70.8 | | |
| Visual Analog Scale | | | 7.6 ± 1.3 | 4–10 |
| WOMAC | | | 73.5 ± 12.4 | 46–96 |

SD, standard deviation; WOMAC, Western Ontario and McMaster Universities osteoarthritis index.

**Table 2a. Radiological and US (osteophytic and cartilage changes) findings with corresponding average VAS and WOMAC score**

| | | | VAS | WOMAC |
|---|---|---|---|---|
| **Parameter** | **n** | **%** | **Mean ± SD** | **Mean ± SD** |
| **K-L grading** | | | | |
| Grade 1 | 22 | 16.9 | 6.36 ± 1.44 | 64.14 ± 12.40 |
| Grade 2 | 21 | 16.2 | 6.31 ± 0.70 | 64.57 ± 5.86 |
| Grade 3 | 38 | 29.2 | 7.34 ± 0.91 | 75.79 ± 8.39 |
| Grade 4 | 49 | 37.7 | 7.85 ± 0.58 | 79.67 ± 12.48 |
| **Musculoskeletal ultrasonological findings** | | | | |
| Medial osteophytes grading | | | | |
| Grade 1 | 15 | 11.5 | 5.85 ± 1.01 | 60.33 ± 7.64 |
| Grade 2A | 20 | 15.4 | 6.58 ± 1.37 | 65.75 ± 12.96 |
| Grade 2B | 30 | 23.1 | 7.02 ± 1.12 | 69.53 ± 11.20 |
| Grade 3 | 21 | 16.2 | 7.50 ± 0.56 | 77.86 ± 5.62 |
| Grade 4 | 44 | 33.8 | 8.04 ± 1.12 | 82.05 ± 9.03 |
| Loss of femoral hyaline cartilage thickness grading | | | | |
| Grade 0 | 2 | 1.5 | 6.25 ± 1.06 | 61.50 ± 6.36 |
| Grade 1 | 13 | 10.0 | 6.32 ± 1.70 | 64.69 ± 14.94 |
| Grade 2A | 23 | 17.7 | 6.62 ± 1.03 | 66.57 ± 9.31 |
| Grade 2B | 41 | 31.5 | 7.23 ± 1.18 | 74.24 ± 10.61 |
| Grade 3 | 51 | 39.2 | 8.22 ± 1.44 | 78.67 ± 11.63 |

VAS, Visual Analog Scale, WOMAC, Western Ontario and McMaster Universities osteoarthritis index, SD: Standard deviation; K-L, Kellgren-Lawrence scores.

**Table 2b. Other US findings with corresponding average VAS and WOMAC score**

| | | | VAS | WOMAC |
|---|---|---|---|---|
| **Parameter** | **n** | **%** | **Mean ± SD** | **Mean ± SD** |
| Synovial effusion grading | | | | |
| Grade 0 | 55 | 42.3 | 6.68 ± 1.27 | 68.75 ± 11.28 |
| Grade 1 | 14 | 10.8 | 6.87 ± 1.34 | 70.36 ± 12.51 |
| Grade 2 | 35 | 26.9 | 7.50 ± 1.08 | 76.74 ± 9.90 |
| Grade 3 | 26 | 20.0 | 8.12 ± 1.06 | 80.73 ± 13.16 |
| Synovial hypertrophy | | | | |
| Grade 0 | 67 | 51.5 | 6.72 ± 1.18 | 68.69 ± 10.94 |
| Grade 1 | 39 | 30.0 | 7.63 ± 1.29 | 77.79 ± 11.23 |
| Grade 2 | 22 | 16.9 | 8.04 ± 1.23 | 79.23 ± 13.09 |
| Grade 3 | 2 | 1.5 | 8.50 ± 0.71 | 86.00 ± 8.49 |
| Medial meniscal protrusion | | | | |
| Yes | 91 | 70.0 | 8.7 ± 1.65 | 80.53 ± 12.52 |
| No | 39 | 30.0 | 7.05 ± 1.26 | 72.41 ± 12.02 |

US, ultrasound; VAS, Visual Analog Scale, WOMAC, Western Ontario and McMaster Universities osteoarthritis index, SD: Standard deviation.

with clinical scores, as shown in Table 3 (correlation between clinical, radiological and musculoskeletal US features).

Values of VAS and WOMAC scores were higher with higher grades on the K-L scale, as shown in Figures 6 and 7. MSK US features such as osteophytes, cartilage thickness loss, effusion, and synovial hypertrophy also increase with an increase in VAS and WOMAC scores and the presence of Baker's cyst and MMP, as shown in Figures 8-19.

**Table 3. Correlation between clinical, radiological and musculoskeletal ultrasound features**

| **Parameters** | **K-L grade** | |
|---|---|---|
| | **Tau** | ***p*** |
| VAS | 0.41 | < 0.001 |
| WOMAC | 0.44 | < 0.001 |
| Medial Osteophytes | 0.55 | < 0.001 |
| Synovial effusion | 0.24 | 0.010 |
| Loss of cartilage thickness | 0.66 | < 0.001 |
| Synovial hypertrophy | 0.32 | 0.001 |
| | | |
| | $r^2$ | *t*-value |
| Presence of Baker's cyst | 0.23 | 0.007 |
| Meniscal protrusion | 0.41 | < 0.001 |
| | | |
| **Musculoskeletal ultrasound features** | | |
| Parameters | VAS | |
| | **Tau** | ***p*** |
| Osteophytes | 0.45 | < 0.001 |
| Synovial effusion | 0.33 | < 0.001 |
| Loss of cartilage thickness | 0.37 | 0.001 |
| Synovial hypertrophy | 0.31 | 0.001 |
| | | |
| | $r^2$ | *t*-value |
| Baker's cyst | 0.29 | 0.001 |
| Medial meniscal protrusion | 0.46 | < 0.001 |
| | | |
| Parameters | WOMAC | |
| | **Tau** | ***p*** |
| Osteophytes | 0.50 | < 0.001 |
| Synovial effusion | 0.31 | < 0.001 |
| Loss of cartilage thickness | 0.39 | < 0.001 |
| Synovial hypertrophy | 0.33 | < 0.001 |
| | | |
| | $r^2$ | *t*-value |
| Baker's cyst | 0.22 | < 0.001 |
| Medial meniscal protrusion | 0.44 | < 0.001 |

K-L, Kellgren-Lawrence scores, VAS, Visual Analog Scale, WOMAC, Western Ontario and McMaster Universities osteoarthritis index, Tau, Kendall Tau-b Correlation coefficient, r2, point biserial correlation coefficient (effect size).

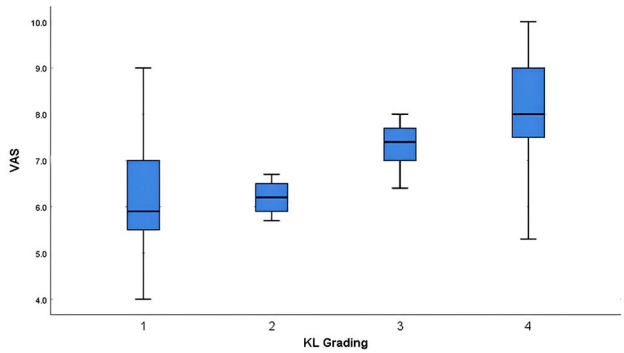


**Figure 6.** K-L grading with corresponding average VAS score.
VAS, Visual Analog Scale; K-L, Kellgren-Lawrence scores.

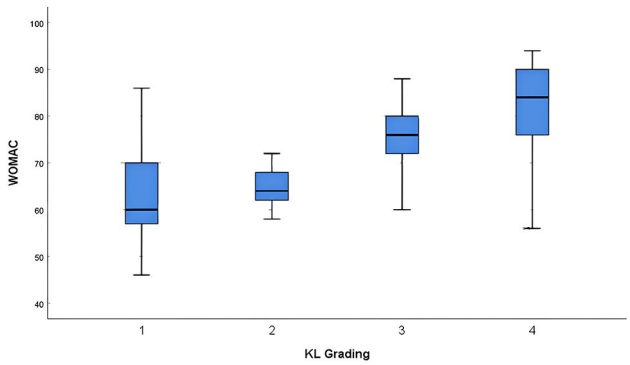


**Figure 7.** K-L grading with corresponding average WOMAC score.
WOMAC, Western Ontario and McMaster Universities osteoarthritis index; K-L, Kellgren-Lawrence scores.

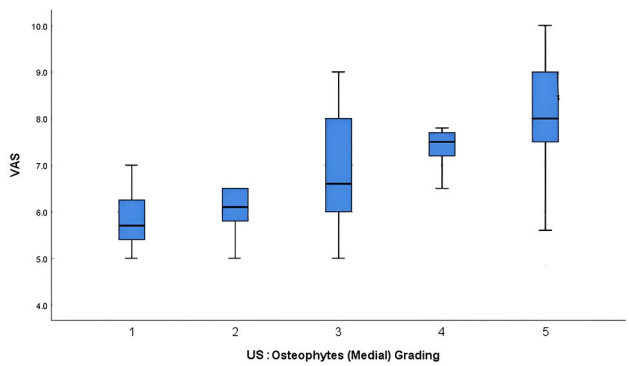


**Figure 8.** Medial osteophytes grading with corresponding average VAS score.
VAS, Visual Analog Scale; US, ultrasound.

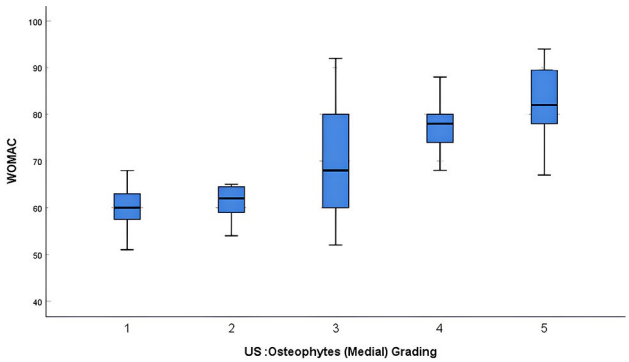


**Figure 9.** Medial osteophytes grading with corresponding average WOMAC score.

WOMAC, Western Ontario and McMaster Universities osteoarthritis index; US, ultrasound.

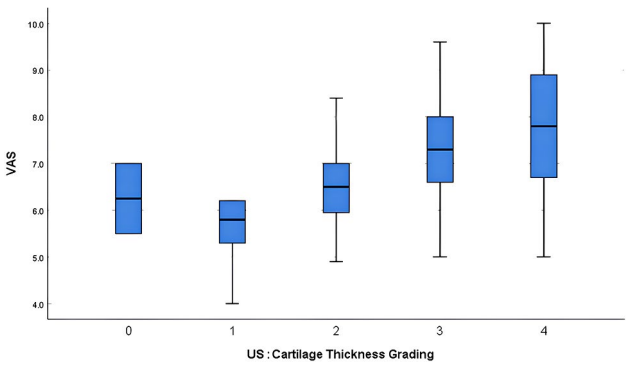


**Figure 10.** Cartilage thickness grading with corresponding average VAS score.

VAS, Visual Analog Scale; US, ultrasound.

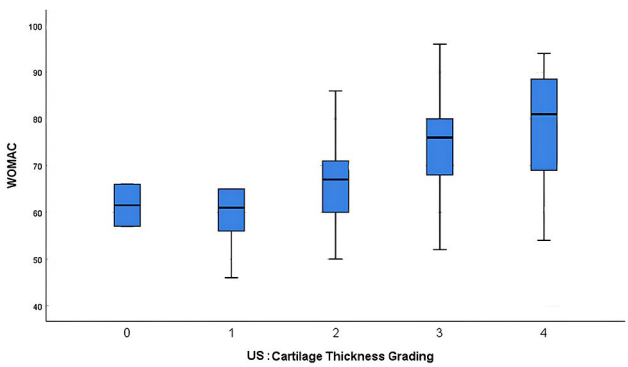


**Figure 11.** Cartilage thickness grading with corresponding average WOMAC score.

WOMAC, Western Ontario and McMaster Universities osteoarthritis index; US, ultrasound.

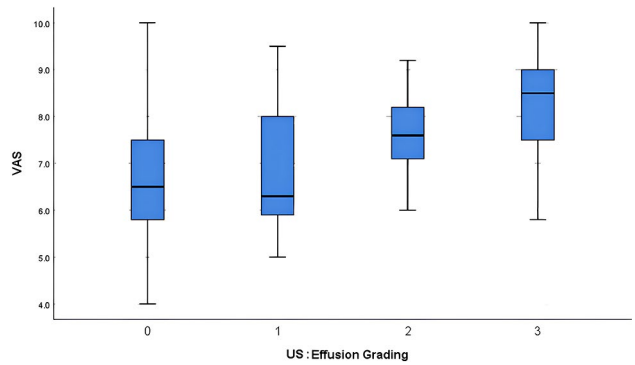


**Figure 12.** Synovial effusion grading with corresponding average VAS score.

VAS, Visual Analog Scale; US, ultrasound.

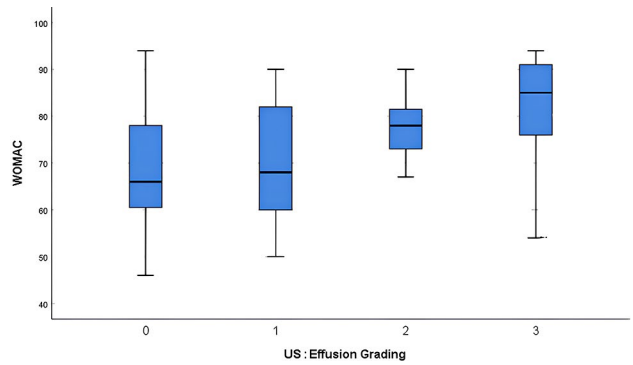


**Figure 13.** Synovial effusion grading with corresponding average WOMAC score.

WOMAC, Western Ontario and McMaster Universities osteoarthritis index; US, ultrasound.

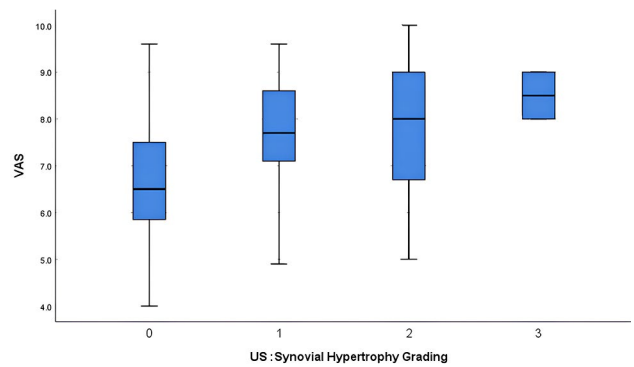


**Figure 14.** Synovial hypertrophy grading with corresponding average VAS score.

VAS, Visual Analog Scale; US, ultrasound.

## DISCUSSION

In the present study, we evaluated the correlation between knee pain and dysfunction with a plain radiograph and musculoskeletal US findings in individuals with OA knee. The patients with a bilateral OA knee were enrolled, and the

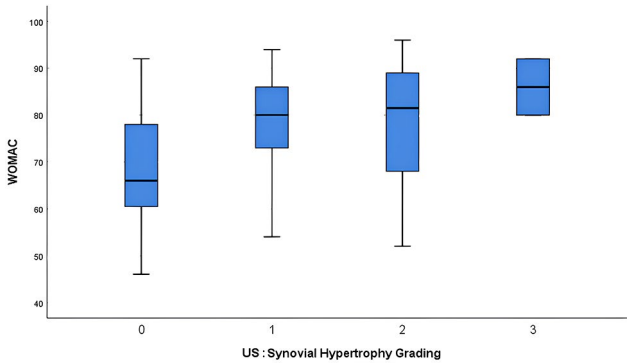


**Figure 15.** Synovial hypertrophy grading with corresponding average WOMAC score.

WOMAC, Western Ontario and McMaster Universities osteoarthritis index; US, ultrasound.

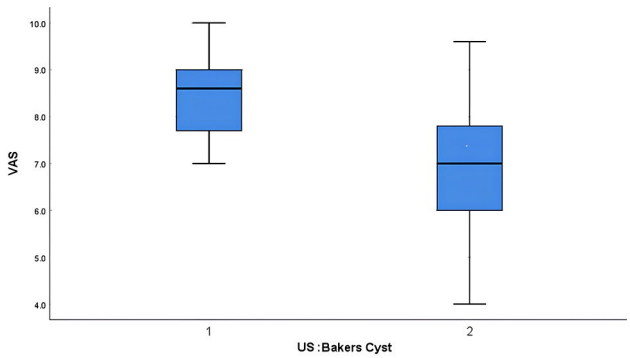


**Figure 16.** Baker's cyst with corresponding average VAS score.

VAS, Visual Analog Scale; US, ultrasound.

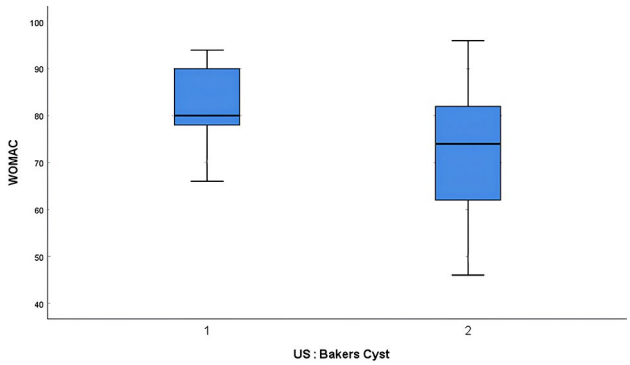


**Figure 17.** Baker's cyst with corresponding average WOMAC score.

WOMAC, Western Ontario and McMaster Universities osteoarthritis index; US, ultrasound.

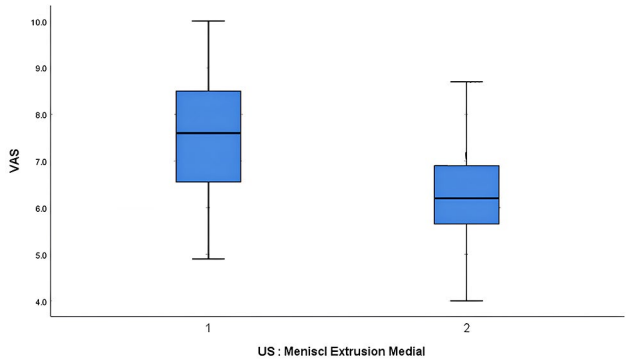


**Figure 18.** Medial meniscal extrusion with corresponding average VAS score.

VAS, Visual Analog Scale; US, ultrasound.

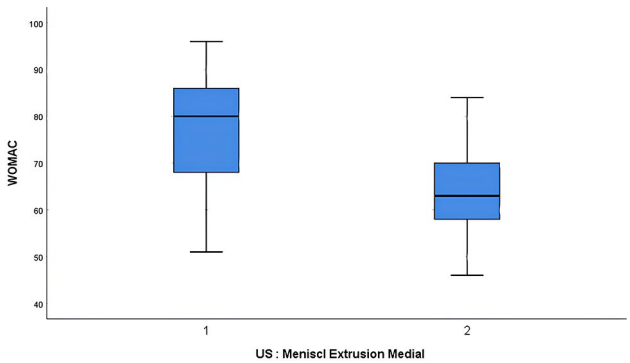


**Figure 19.** Medial meniscal extrusion with corresponding average WOMAC score.

WOMAC, Western Ontario and McMaster Universities osteoarthritis index; US, ultrasound.

most symptomatic knee was selected for the evaluation. Our study results showed that the left-sided knee was affected more, possibly due to maximum wear and tear on the left side since the left lower limb was dominant. According to a study, OA knee was most prevalent in elderly, those who lead sedentary lifestyles (85%), those who were overweight or suffering from obesity (46.2%), and women (76.9%).[4] Increase in age, female sex, obesity and sedentary lifestyle are well-known risk factors for OA knee.[4] Our findings are also consistent with the literature.

In our study, increasing K-L grade was associated with higher mean pain and functional impairment scores. A significant positive correlation was observed between K-L grade and pain severity as measured by the VAS, as well as functional outcomes assessed using the WOMAC score. These findings are consistent with the study that found K-L graded radiographic severity and individual radiographic characteristics to be strong predictors of pain severity and consistency.[16] An Indian study conducted in northern India with

almost identical patient demographics found a substantial link between VAS, WOMAC score and K-L grading.[13] Serban et al.[10] found a Spearman correlation value of 0.432 for the VAS and 0.363 for the WOMAC score, indicating that higher K-L grades resulted in considerably higher VAS and WOMAC ratings. A systematic review also found that OA of a higher grade (K-L Grade ≥ 3) was a stronger predictor of pain than OA of a lower grade (K-L Grade ≤ 2).[17]

However, some studies showed the discordance between clinical scores and radiological findings. The main reason for this difference might be the difference in the characteristics of the sample. The sample of Hart et al.[18] was women, chosen from general practices, screening facilities, and individuals who previously visited a hospital for a non-rheumatic condition. The study by Felson[19] was a population-based study that enrolled independently living elderly. In the study by Claessens et al.,[20] the data were derived from a population survey, and they collected weight-bearing radiographs of the knee from individuals who are 45 and older, regardless of symptom and also selected the right knee only. In the present study, we considered musculoskeletal US findings such as osteophytes, cartilage thickness, meniscal extrusion in the knee's medial compartment, joint effusion, hypertrophy of synovium, and the presence of Baker's cyst. The most frequently observed musculoskeletal US findings in this study were osteophytes, femoral trochlear cartilage damage, and MMP.

Furthermore, we observed a positive correlation between the WOMAC and VAS scores concerning medial osteophytes. This correlation supports the conclusions made by Serban et al.,[10] who graded the osteophytes according to their size. Medial osteophytes were independent predictors of the WOMAC score and were linked to pain on palpation. Singh et al.[13] also reported a positive correlation between VAS and WOMAC scores and osteophytes. The mean osteophyte length was higher at the medial tibiofemoral joint space than at the lateral (tibiofemoral joint space, medial: 3.91 ± 1.78 cm *vs.* lateral: 2.80 ± 1.74 cm), but grading of osteophytes was not done.

Using MRI for the evaluation of OA knee, Kaukinen et al.[21] reported a substantial association between pain intensity and osteophytes. The presence of osteophytes in OA is a result of the development of new bone formation near the margin of the joint and can be associated with periostitis, explaining and generating pain.[22] In addition, a positive correlation was shown between MMP and pain, both VAS and WOMAC scores. We considered the presence of MMP in the affected knee, but we did not perform grading. In our study, the presence of MMP was a frequent and common finding, as was the presence of osteophytes.

Kijima et al.[23] positively correlated pain with MMP. The authors concluded that the MMP of the knee was greater in patients with pain than those without pain in knees with the same degree of OA. Singh et al.[13] also found a positive correlation between MMP and pain (VAS) as well as functional score (WOMAC). However, Serban et al.[10] covered no correlation between MMP and pain severity and functional limitation (VAS and WOMAC). They enrolled both knees affected with OA in the study, while studies that showed a positive correlation enrolled the most symptomatic knee only. Another reason may be the distribution of patients according to the K-L grading. In the study conducted by Serban et al.[10] maximum percentage of patients were in K-L Grade 1 (41.5%), while the maximum participants in our study and the Indian study done by Singh et al.[13] were of K-L Grade 4. The inclusion criteria of Kijima et al.[23] were patients with K-L Grade > 2.

According to Podlipská et al.,[12] medial osteophytes and the degree of MMP by assessed by musculoskeletal US were superior to conventional radiological evaluation in the management of OA knee. However, the authors did not examine the association between these imaging findings and pain. Osteophytes demonstrated by musculoskeletal US showed a significant correlation with degenerative changes of hyaline cartilage by arthroscopy.[24]

Effusion is a risk factor for the appearance of pain in persons with OA knee.[25] We found a positive correlation between joint effusion and

pain scores in our study. That is, patients with large joint effusions had high VAS and WOMAC scores. Hill et al.[26] and Naredo et al.[27] also reported a substantial correlation between effusion and pain in OA knees. They concluded the joint effusion in OA knee was independent of radiographic OA severity and demographic features of the patient such as body mass index (BMI), age and disease duration.

Patients with OA knees experience two forms of pain, inflammatory and mechanical pain. Mechanical pain is of biomechanical origin and relates to movements of joints, such as climbing stairs and walking, whereas flare-ups bring on pain and inflammation in the joints.[28] A positive correlation was found between synovial hypertrophy and pain scores. This was in accordance with de Miguel Mendieta et al.,[25] with a p-value of 0.001, they noticed a higher incidence of effusion in the suprapatellar fossa in knee OA with pain, and they also discovered that the presence of effusion raised the likelihood of pain by 6.4 times. Chan et al.[9] showed a moderately strong correlation between suprapatellar synovitis and pain on sitting, not with walking and climbing stairs, suggesting that pain due to synovial hypertrophy is inflammatory rather than mechanical.

Knee OA is characterized by pain and cartilage degradation as the primary pathological lesion in OA. In the present study, a high VAS and WOMAC score was associated with significant femoral trochlear cartilage injury. Serban et al.[10] found that cartilage loss was the main predictor of pain in OA knees when VAS was utilized for pain measurement, and there was also a strong link with the WOMAC score. These findings were consistent with those reported by Singh et al.[13] Musculoskeletal US studies revealed a link between pain and hyaline cartilage degeneration.[9] The degenerative cartilage alterations discovered by arthroscopy were consistent with cartilage degradation detected by musculoskeletal US. The MRI investigations revealed a link between pain and cartilage degradation.[21,29]

Baker's cyst is a frequent finding of symptomatic OA knee and is positively associated with high VAS and WOMAC scores and increased limitation of knee flexion range of motion. With a two-year follow-up, Bever et al.[30] discovered a long-term relationship between discomfort and radiological advancement as well as a baker's cyst.

Nonetheless, there are several limitations that should be acknowledged. First, the number of patients was relatively small, particularly in lower K-L grades (K-L Grade 1 and K-L Grade 2), 40% of patients were in K-L Grade 4. Achieving balanced representation across all K-L grades requires recruitment from multiple levels of the healthcare system, including primary, secondary, and tertiary care centers. Second, we evaluated the most symptomatic knee, although the other knee had osteoarthritic changes, and we did not perform a comparison of patients with symptomatic OA with the control group. Third, we utilized various grading systems for various signs of OA knee for evaluating US features. However, there is a lack of standardization and validation of the scoring system. Although the center is a final referral unit and a tertiary care center, we did not consider the data of previous treatment. Finally, MRI is the most accurate imaging technique for the evaluation of OA. Musculoskeletal US findings were not compared with MRI, as bone marrow lesions are an important source of pain in OA.

In conclusion, radiographic severity and the severity of musculoskeletal US abnormalities, such as medial osteophytes, loss of medial femoral-trochlear cartilage thickness, synovial hypertrophy, joint effusion, and MMP, were significantly and positively associated with pain levels in knee OA. There was a significant association between pain levels and the presence of MMP and loss of medial femoral trochlear cartilage. According to our study findings, pain scores and the existence of a baker's cyst in musculoskeletal US were positively correlated. These findings suggest that musculoskeletal US may provide valuable complementary data to conventional radiography in evaluating pain-related structural pathology in knee OA.

**Declaration of Conflicting Interests**

The authors declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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**Author Contributions**

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**Data Availability**

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

**AI Disclosure**

The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

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