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Evaluation of Ultrasonographic Findings in Patients with Knee Osteoarthritis: Correlations with Western Ontario and McMaster Universities Osteoarthritis Indexes

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Abstract

Introduction: Osteoarthritis is the most common chronic joint disease that affects both the elderly and the middle-aged people. This disease is the most common cause of limitation for the elderly and middle-aged people in daily activities significantly affecting the quality of their lives. The aim of this study was to evaluate the ultrasonographic findings in patients with knee osteoarthritis and its correlation with Western Ontario and McMaster Universities Osteoarthritis Indexes (WOMAC).

Materials and Methods: In this cross-sectional study, patients with knee osteoarthritis, who were referred to the rheumatology clinic of Imam Hospital from April 2020 to June 2021, were evaluated by radiographic and laboratory assessment. Laboratory tests included Rheumatoid Factor (RF), Anti-Cyclic Citrullinated Peptide (Anti-CCP), Antinuclear Antibodies (ANA), Erythrocyte Sedimentation Ratio (ESR) and C-Reactive Protein (CRP); patients with positive inflammatory and serological tests were excluded from the study. Then, patients with osteoarthritis were visited by a radiologist for ultrasound findings and underwent ultrasound. In addition, the WOMAC questionnaire was administered at the same time.

Results: 138 patients over 40 years old and 85.5% of whom being female were studied. The joint dryness score was significantly higher in patients with left synovial effusion (4.04 vs. 2.51; $p = 0.001$). In patients with right synovial hypertrophy, the mean overall score of WOMAC and its sub-branches was significantly higher (61.26 vs. 47.80; $p = 0.001$); also, mean joint dryness score in patients with left synovial hypertrophy is higher (4.15 vs. 3.17; $p = 0.017$).

Conclusion: The results of the present study showed that in terms of synovial inflammation, which includes hypertrophy and synovial effusion, there is a direct relationship with patients' WOMAC score, since ultrasound modality is non-invasive and available everywhere; moreover, the cheapness of this modality makes it possible to follow-up patients with osteoarthritis. This modality is also reliable in assessing synovial changes, but more accuracy is needed in assessing cases such as osteophyte.

Keywords: Clinical examination, Knee osteoarthritis, Ultrasound, WOMAC.

1. Introduction

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nee osteoarthritis is one of the most common musculoskeletal diseases that usually leads to knee pain and inability to

move [1]. Among the elderly, knee osteoarthritis is the leading cause of chronic disability in developed countries. Nearly 100,000 people in the United States are unable to get out of bed or go to the bathroom without help due to osteoarthritis of the knee or hip [2].

The prevalence of osteoarthritis of the knee in people over 65 is about 35% [3]. Some studies suggest that the severity of clinical symptoms such as nocturnal pain, morning dryness, and swelling of the joints is higher in women than in men, and similarly radiographic evidence of osteoarthritis of the knee, especially symptomatic osteoarthritis, is higher in women than men.

Various studies have suggested that ultrasound has features that make it an effective and accurate tool for assessing osteoarthritis of the knee [4-8]. Ultrasound evaluation of articular cartilage content and its injuries are important for accurate diagnosis of knee osteoarthritis. Ultrasound findings in osteoarthritis of the knee include the outer margin of the cartilage, loss of cartilage transparency, and increased echogenicity, indicating damage to the cartilaginous structure [9,10]. Osteophytes are among the emerging signs, but the identification of small osteophytes requires high-resolution devices [10]. On the other hand, ultrasound can show a very low amount of synovial effusion in the lateral suprapatellar pouch of patients with knee osteoarthritis [11]. Observation of synovial hypertrophy in patients with knee osteoarthritis can be signs of disease activity [12].

Due to the relatively high prevalence of osteoarthritis in Iran and the inconsistency of radiographic findings and clinical signs of pain intensity in patients, this study was conducted on changes in the osteoarthritis joint in the form of synovial hypertrophy, synovial effusion, osteophyte bursitis and meniscus protrusion. Identifying and searching for the relationship between pain intensity and functional impairment based on the WOMAC questionnaire with ultrasound findings is essential. Therefore, this study is useful both in terms of finding etiologies and joint sonographic changes related to pain and in terms of finding solutions (according to sonographic findings) to treat and control patients' symptoms.

2. Materials and Methods

Patients with knee osteoarthritis who were referred to the rheumatology clinic of Imam Khomeini Hospital in Ardabil from April 2016 to June 2021 for other diseases involving the joints undergoing radiographic evaluation and laboratory tests including RF, Anti-CP, ANA, ESR and CRP were included in the study. The participants also involved patients with knee osteoarthritis based on the American college of Rheumatology (ACR) criteria.

A total of 276 knees were studied in both patients' knees. The sample size was selected according to

previous studies with a reliability coefficient of 3 and an error coefficient of 2, with a statistical formula of 1; the sampling method was census. Patients who had received intra-articular injections of corticosteroids and hyaluronic acid, those with positive inflammatory and serological tests, and those with a history of knee replacement, metabolic diseases and recent and obvious knee trauma were excluded from the study. Patients with osteoarthritis were then visited by a fellow radiologist for ultrasound findings; they underwent sonography, and at the same time a WOMAC questionnaire was completed for each of them.

The WOMAC questionnaire is an international and standardized questionnaire to assess the therapeutic outcomes of patients with knee osteoarthritis. The three criteria of pain (5 questions), joint dryness (2 questions), and physical function (17 questions) are quantitatively evaluated in this tool. For each question, there are 5 options that give the answers from zero to 4 points and a total of zero to 96 points. The number 96 indicates the maximum problem and the number zero indicates the absence of the problem. A decrease in the WOMAC score is a sign of recovery. The present study with the code (IR.ARUMS.REC.1399.185) was approved by the Ardabil university ethics committee.

Statistical Analysis

Data were collected by a checklist and then analyzed by using SPSS for Windows release 21.0 (SPSS Inc., IL, USA). First, the normality of the data was checked by Kolmogorov-Smirnov test. The data of the study had a normal distribution. The results were presented as mean \pm standard deviation (SD) or standard error (SE) range. Then, various statistical tests including independent t-test, chi-square test and one-way analysis of variance were used to examine the relationship between quantitative and qualitative data. Statistical significance was considered to be $P < 0.05$.

3. Results

The mean age of the patients was 57.33 ± 9.12 years with a median of 57.5 years. The minimum age of patients was 40 years and the maximum was 87 years. 20 patients (14.5%) were male and 118 patients (85.5%) were female. The mean total score of WOMAC in the studied patients was 53.94 ± 19.72 with a median of 55 and a range of 7-88. There was no statistically significant difference between positive and negative cases of left and right synovial effusion, left hypertrophy with total WOMAC score of patients,

but the relationship between positive and negative hypertrophy on the right and total WOMAC score was statistically significant (Table 1). The mean of WOMAC in patients with right synovial hypertrophy

was significantly higher than patients without right synovial hypertrophy; based on the boxplot, this difference between mean and median of WOMAC in two groups was significant. (Figure 1).

Table 1. Relationship between some variables and WOMAC score in patients with knee osteoarthritis

Variables		n	Mean±SD	p-value
Right synovial hypertrophy	Positive	63	61.3±19.8	0.001
	Negative	75	47.8±17.6	
Left synovial hypertrophy	Positive	71	57.04±20.3	0.057
	Negative	67	50.7±18.8	
Left synovial effusion	Positive	105	55.7±19.8	0.062
	Negative	33	48.5±18.6	
Right synovial effusion	Positive	84	54.56±20.9	0.589
	Negative		52.9±17.8	
Right Osteophyte	Positive	115	53.9±20	0.91
	Negative	23	54.4±20.4	
Left Osteophyte	Positive	117	53.7±21.1	0.56
	Negative	21	55.4±9.6	
Right baker cyst	Positive	33	58.5±23.3	0.18
	Negative	105	52.5±18.4	
Left baker cyst	Positive	27	56.6±24.1	0.52
	Negative	111	53.3±18.6	
Protrusion of the right meniscus	Positive	127	54.2±20.2	0.44
	Negative	11	50.6±13.9	
Protrusion of the left meniscus	Positive	129	53.8±20.4	0.26
	Negative	9	56.6±4.9	

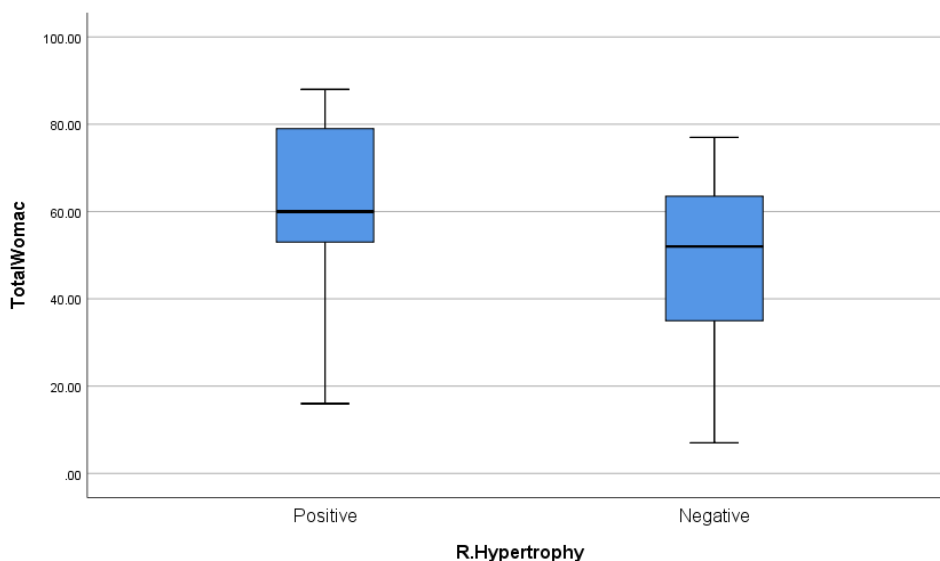


Figure 1. Relationship between right synovial hypertrophy and WOMAC score in patients with knee osteoarthritis

4. Discussion

As mentioned, most of participants in the present study were female. According to the results presented by Kaban et al. [13], the loss of cartilage thickness started during the pre-menopausal period in women

and during the post-menopausal period. It also persists in women with osteoarthritis. In addition, recent studies have shown that obesity is one of the serious risk factors for osteoarthritis of the knee, which has not been studied in the present study [14].

In general, based on the results of the current study,

there was a significant relationship between joint dryness and synovial effusion in patients with osteoarthritis. There was also a statistically significant relationship between WOMAC score and synovial hypertrophy in the sense that patients with positive synovial hypertrophy score had higher WOMAC score (61.26 vs. 47.80; $p = 0.001$). Consistent with the present study, in Malas et al.'s, a statistically significant relationship was observed between joint pain and synovial hypertrophy with WOMAC score. Their study also reported a direct relationship between articular cartilage thickness reduction and WOMAC score [8]. Based on recent studies, the above-mentioned finding can be justified in light of the pathological changes in patients with osteoarthritis of the knee that affect the synovial tissue, bone or both, so that the mentioned cases play a major role in causing pain and under. They affect the patient's motor posture and present with a clinical flare-up of osteoarthritis of the knee [15].

Chen et al. [7] and Razed et al. [5] reported a direct correlation between ultrasound findings and clinical examination results in patients with osteoarthritis of the knee with synovial inflammation and structural damage to the knee joint. Cartilage changes, osteophyte, and increased synovium thickness had higher WOMAC scores and poorer clinical outcome. In addition, Chen et al. reported a direct correlation between ultrasound grading and overall WOMAC score and patient pain [7]. The EULAR study [16] also reported that synovial inflammation (including synovial hypertrophy and effusion) was common in patients with osteoarthritis of the knee and was easily detected by ultrasound and clinical examination.

In the present study, the pain score of WOMAC questionnaire was significantly higher in patients with right synovial hypertrophy (12.88 vs. 10.02; $p = 0.001$). Pain is one of the most common symptoms in patients with knee osteoarthritis and has a complex etiology that has not yet been fully elucidated. The results of the present study show that synovial hypertrophy following synovial inflammation in patients with osteoarthritis of the knee can lead to joint pain. The role of synovium inflammation in the clinical course of knee osteoarthritis has not been considered important in recent years, but some studies have shown that knee synovitis can play an important role in disease progression [17]. In the present study, no statistically significant relationship was observed between other ultrasound findings (osteophyte, virgin cyst and meniscus protrusion) and WOMAC score. Unlike our study, Chiba et al.'s [18] reported that a

direct relationship between exacerbation of knee osteoarthritis and the size and presence of virgin cysts. In line with our study, however, in Creamer et al.'s [19], no relationship was observed between the presence of osteophyte and its size with WOMAC score in patients.

Low sample size, qualitative ultrasound evaluation of patients and lack of evaluation of specific knee joint activities apart from WOMAC score in patients have been the limitations of the present study.

Another method of assessing the condition of the joint in patients with osteoarthritis of the knee is the use of radiographic images and the Kellgren-Lawrence grading system [20, 21] in which the patient receives X-rays. This method is the most common method of radiographic segmentation where the reduction of joint space is usually the main radiological view to assess the severity of the disease. The presence of osteophyte can be the most important view for the diagnosis of osteoarthritis in the study population [22]. The association between the severity of osteoarthritis pathology and symptoms is negligible. Many people with advanced radiographic changes have no clinical signs. The disability of patients with osteoarthritis is more due to the association with quadriceps muscle weakness than joint pain or the severity of radiographic involvement. In addition, patients with less psychosocial support had more pain [2]. Past studies have shown that there is a clear heterogeneity between the severity of radiographic and clinical symptoms and functional capacity in osteoarthritis. In one study, a very weak correlation was reported between clinical symptoms and radiographic indices ($r = 0.196$; $p = 0.286$). Therefore, while more than 90% of people over the age of 40 had radiographic changes in osteoarthritis in weight-bearing joints, only 30% of them were symptomatic [23].

In the study of Abd El Monaem et al. [24] and that of Cubukcu et al. [25], it was reported that there is no relationship between the K-L rating system and the WOMAC score. Contradictory results have been published regarding this system and its correlation with K-L system. In Serban et al.'s [26], a very good correlation between the K-L system and the WOMAC score pain subset was reported. Reduction of the space between the joints is an initial finding in conventional radiography in patients with knee osteoarthritis. The results of recent studies have also shown a moderate correlation between the reduction of space between the joints and the loss of cartilage [8]. In contrast, Kaban et al. [13] reported no significant relationship between cartilage thickness

and the K-L system.

5. Conclusion

The results of the present study showed that synovium inflammation was directly related to the WOMAC score; patients with such a problem also had higher WOMAC scores. Since local and systemic inflammation play an important role in exacerbating structural damage to the joint as well as causing pain and reduced joint function, treating key aspects of inflammation can prevent joint pain and structural changes. On the other hand, ultrasound modality is a non-invasive method which is accessible and affordable; unlike simple radiography, this modality can be used in diagnosing synovium inflammation; besides, it is possible to follow patients. All in all, ultrasound modality is an efficient and reliable method.

Thus, it is warranted to examine the issue with larger sample size along with Magnetic Resonance Imaging (MRI). Moreover, future studies can follow up patients during the treatment by considering the psychological extent of depression and its relationship with knee pain in elderly patients with knee osteoarthritis.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the Ardabil University of Medical Science (Code: IR.ARUMS.REC. 1399.185).

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Author's contributions

All authors equally contributed to preparing this article.

Conflict of interest

The Authors declare that there is no conflict of interest.

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