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The association between diabetes mellitus and functionality in knee osteoarthritis: a cross-sectional study

Serdar Kaymaz[1], Sanem Aslıhan Aykan[2]

[1]Ankara Atatürk Training and Research Hospital, Department of Physical Medicine and Rehabilitation, Ankara, Turkey
[2]Yeditepe University Medicine Faculty Hospital, Department of Physical Medicine and Rehabilitation, Istanbul, Turkey

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ABSTRACT

Objective: The aim of this study was to determine the roles of diabetes mellitus (DM) on quality of life, function of knee, and muscle strength in patients with knee osteoarthritis (OA).

Material and Method: This single-center, case-control study prospectively enrolled outpatients with knee OA visiting a physical therapy and rehabilitation clinic. The patients were grouped according to the presence of DM diagnosis. Demographic data, disease duration, and medical treatments of patients were recorded. Clinical parameters, radiographic grading (Kellgren-Lawrence grades), functional scales of the knee and quality of life were evaluated.

Results: The study included 82 participants [age: 61.3±6.7 years; female: 76.8%]. The mean Western Ontario and McMaster Universities Osteoarthritis Index of OA patients with (n=37) and without DM (n=45) were 45.79±18.04 vs. 65.94±16.23, respectively (p=0.003). The Hb A1c levels showed a negative correlation with Knee Injury and Osteoarthritis Outcome Score components (pain, quality of life, sports, daily activities, symptom duration) (p<0.001, r:-0.440; p<0.001, r:-0.393; p<0.001, r:-0.396; p<0.001, r:-0.336; p:0.002, r:-0.342, respectively) and also, a negative correlation with knee flexion degree (p<0.001, r:-0.401).

Conclusion: DM has a negative effect on quality of life and activities of life in knee OA.

Keywords: Osteoarthritis, diabetes, functionality, quality of life

INTRODUCTION

Diabetes mellitus (DM) is the ninth causes of death worldwide and causes many defined complications that attract the attention of the patient and physician (1). The musculoskeletal system, which constitutes 60-70% of the body weight, consists mainly of muscles, joints, bones, and soft tissues surrounding these structures (2) Even though the relationship of DM with musculoskeletal system has not been fully defined (3,4), a large number of diabetic patients suffer from musculoskeletal system complications that cause significant morbidity in their lives (3,4).

There are many studies in the literature compiling the relationship between DM and musculoskeletal complications. Hoff et al. (6) reported that the relative risk (RR) for musculoskeletal system complication is 1.6 in diabetic patients. Mathew et al. (7) reported that the most commonly described were diabetic solid hand syndrome, dupuytren contracture, adhesive capsulitis, carpal tunnel syndrome, charcot neuropathic osteoarthropathy, diabetic amyotrophy, muscle infarction, diffuse idiopathic skeletal hyperostosis (DISH), reflex sympathetic dystrophy and septic arthritis. Even though, the relationship between osteoarthritis and DM on proven medical basis is questionable, DM can negatively affect joint cartilage and accompany of OA is inevitable (8). Hyperglycemia causes oxidative and osmotic stress causing lesions in the eyes, kidneys and other tissues (9). Moreover, previous studies have determined that hyperglycemia is a risk factor for OA (10,11), It was also found that the proteoglycan ratio and molecular weight were lower compared to diabetic cartilage than normal cartilage (12).

In this present study, we analyzed the effect of DM on knee OA patients in terms of knee functionality, quality of life, pain level, and muscle strength. We also aimed to determine any potential relationship between the DM duration, glycemic control, and knee OA to able to define diabetes metabolic impact on OA rather than mechanic.

Corresponding Author: Sanem Aslıhan Aykan, sanemaykan@hotmail.com
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MATERIAL AND METHOD

Study Design and Participants

This observational and case-control study was conducted in Ankara Training and Research Hospital and approved by Noninvasive Clinical Researches Ethics Committee (Date: 02.22.2017, Decision No:46). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

The data were collected from Ankara Training and Research Hospital outpatient clinic between February and June 2017 who applied to our hospital physical therapy outpatient clinics for knee pain and diagnosed with primary / idiopathic knee OA according to the American Rheumatology Criteria (ACR) were included in the study (13). Inclusion criteria were; (i) patient age between 45 and 90 years, (ii) knee OA diagnosis based on the American Society of Rheumatology (10), and (iii) ability to cooperate and read and write in Turkish. Exclusion criteria were the presence of any inflammatory or rheumatological disease such as rheumatoid arthritis, chondrocalcinosis, psoriatic arthritis and hemochromatosis that may lead to secondary OA. The participants were grouped as with or without DM (Type 2). The diagnosis of DM was self-reported and confirmed by the national health database.

Clinical and demographic features of all participants patients were recorded. Height and weight of all patients included in the study were questioned and body mass index (BMI) was calculated. The Hba1c levels of diabetic patients and auxiliary devices (wheelchair, walker, walking stick, tripod) used by patients during ambulation were recorded.

Clinical Parameters

1. Range of Motion: Extension (0-10 degrees) and flexion (130-140 degrees) supine lying, the angle between the distal femur tip and the proximal tibial tip was measured by goniometry.
2. Manual muscle strength: Patients' quadriceps muscle strength was tested with manual muscle strength.
3. Functional Ambulation Categories (FAC): It is rated between 0 and 5. It is divided into six categories. It is a scale that evaluates ambulation skills of patients (14).

Functional Scales of Knee OA

1. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): This scale consists of 24 items. It is a scale that examines the pain, stiffness, and physical function of OA. It can measure changes in the patient's condition after both surgical and pharmacological interventions. Tüzün et al. (15) determined the reliability and validity of this index in Turkish in 2005.
2. Lequesne Index: It consists of 3 main sections: pain / discomfort, daily life activities and maximum walking distance. It consists of 10 items (16).
3. Knee Injury and Osteoarthritis Outcome Score (KOOS): It consists of 42 questions. It has 5 subgroups: pain, sports, daily life activities, quality of life, other symptoms, and functional status in leisure time activities. Each subgroup is scored between 0-100 (0 indicates that there are serious problems and 100 indicates no problems). Peker et al. (17) showed the reliability and validity of the Turkish version in 2007.

Evaluation of quality of life

The quality of life was evaluated with a scale consisting of 8 subgroups with 36 items (SF-36). These subgroups are vitality, physical function, general health, pain, social function, role limitation in physical and emotional aspects and mental health. Koçyiğit et al. (18) demonstrated the reliability and validity of SF-36 in our community in a study conducted in 1999.

Radiography

In order to evaluate knee osteoarthritis, knee radiographs were taken in the anterior-posterior and lateral positions with the foot 20-30 degrees flexed and 10 degrees internal rotated. Ratings were made according to Kellgren-Lawrence radiological evaluation criteria (19).

Statistical Analysis

The Statistical Package for the Social Sciences for Windows (version 20.0, IBM.Corp., Armonk, NY, 2011) was used for data analysis, and normal distribution was determined using the Kolmogorov-Smirnov test. Data are expressed as mean±standard deviation or percentage values. Where appropriate, case-control comparisons were performed by Student t, Mann-Whitney U, or Chi-squared test. Pearson and Spearman's coefficients determined the correlation. Statistical significance was set at $p<0.05$.

RESULTS

The mean age of the study population was 61.33±6.7 years, and 63 patients (76.8%) were female. The mean age of patients with DM (n=50) was 61.38 ±9.89 years, and those without DM (n=47) was 59.32±9.98 years. The frequency of females in the patients with DM and without the diabetic group were 76.4% and 78.4%. No significant difference was found between the groups regarding sex, age, BMI, and dominant hand ($p>0.05$). The mean duration of DM was 11.76±6.89 years, and Hemoglobin A1c (HbA1c) averaged was 8.35±2.02

in patients with DM. There was no statistically significant difference between the two groups in terms of demographic characteristics. But a statistically significant difference was found between the case and the control group in terms of knee function scales, daily life activities, range of motion, FAC, manuel muscle strength and KLS stage. The demographic and clinical features of the patients are shown in **Table 1**.

Table 1. Clinical, demographic, and pain characteristics of knee osteoarthritis patients with and without DM

	Without DM (n=45)	With DM (n=37)	p value
Age, year (mean± SD)	59.32 ± 9.98	61.38 ±9.89	0.354
BMI, kg/m² (mean±SD)	30.41±6.29	33.03±5.63	0.051
Diagnosis duration of DM, years (mean± SD)	-	11.76 ± 6.89	-
HbA1c, (mean± SD)	-	8.35 ± 2.02	-
Sex n(%)			0.763
Male	8 (21.6)	11 (24.4)	
Female	29 (78.4)	34 (76.4)	
Muscle strength, n (%)			**<0.001**
3/5	8 (17.8)	3 (8.1)	
4/5	28 (62.8)	7 (18.9)	
5/5	9 (20)	27 (73)	
Auxiliary device use, n (%)	13 (28.9)	6 (16.2)	0.176
Existence of polyneuropathy, n (%)	31 (68.1)	0	**<0.001**
Functional ambulation score, n (%)			**0.001**
3	22 (48.9)	5 (13.5)	
4	10 (22.2)	7 (18.9)	
5	13 (28.9)	25 (67.6)	
Kellgren-Lawrence scale			**<0.001**
Grade 1-2	7 (15.6)	23 (62.2)	
Grade 3	33 (73.3)	13 (35.1)	
Grade 4	5 (11.1)	1 (2.7)	
WOMAC	65.94±16.23	45.79±18.04	**0.003**
Lequesne	16.62±4.22	10.19±4.45	**<0.001**
Knee injury and osteoarthritis outcome score			
Quality of Life	45.49±23.42	22.8±19.51	**0.049**
Pain	56.81±18.12	35.98±14.5	**<0.001**
Symptoms	62.37±19.09	43.01±17.57	**0.008**
Sports	37.03±25.99	15.56±16.49	**0.002**
Activities of Daily Living	55.72±20.87	35.1±16.51	**0.002**
Short Form of 36			
Function	16.33±14.48	32.32±25.81	**0.031**
Pain	28.94±15.04	45.14±19.93	**0.035**
Range of Motion			
Flexion (mean±SD)	120.22±13.6	132.43±7.87	**<0.001**
Extension (mean±SD)	-0.35±1.6	1.98±2.51	**<0.001**

DM: diabetes mellitus, SD: standard deviation, BMI: body mass index, HbA1c: hemoglobin A1c, VAS: visual analog scale, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index. Chi-square test, Mann Whitney-U test, Fisher Exact test and Student's t test were used in comparisons according to the distribution characteristics of data. Statistically significant variables are shown in bold.

The correlation of the knee functional indexes of the diabetic patients and SF-36 components with DM diagnosis and Hb A1c were calculated. While there was a weak negative correlation between Hb A1c and KOOS components (pain, quality of life, sports, daily activities, symptom duration), but there was a moderate negative correlation between knee flexion restriction and Hb A1c (r = -0.401) (**Table 2**).

Table 2. Correlation of length of DM and hemoglobin A1c level with clinical findings

	Diagnosis duration of DM		HBA1C	
	p	r	P	r
Knee injury and osteoarthritis outcome score				
Pain	**<0.001**	0.513	**<0.001**	-0.440
Symptom	**0.001**	0.485	**0.001**	-0.343
Activities of daily living	**<0.001**	0.654	**<0.001**	-0.396
Quality of life	**<0.001**	0.683	**0.001**	-0.336
Sports	**0.001**	0.495	**0.002**	-0.342
WOMAC	**<0.001**	-0.561	**<0.001**	0.410
Lequesne	**<0.001**	-0.666	0.275	0.462
Short form of 36				
Pain	0.373	-1	**0.013**	-0.273
Function	0.226	-0.135	0.073	-0.199
Range of motion				
Flexion degree	0.056	0.287	**<0.001**	-0.401
Extension degree	0.038	-0.310	**0.001**	0.347

DM: diabetes mellitus, SD: standard deviation, BMI: body mass index, HbA1c: hemoglobin A1c, VAS: visual analog scale, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index. Spearman`s correlation test was used in comparisons according to the distribution characteristics of data. Statistically significant variables are shown in bold.

DISCUSSION

Although it is common in diabetic patients, the relationship between DM and OA development has not been established definitively on evidence-based medicine. However, studies at the molecular level showed that adipokine hormone has a potential contribution to the development of OA (20). In our study, it was found that knee functional indices, joint range of motion, radiographic grading and quality of life were worse in diabetic patients compared to non-diabetic patients with gonarthrosis. It was observed that the diagnosis duration of DM and Hb A1c level were correlated with knee functional indices, quality of life scales and joint range of motion limitation, respectively.

Although the number of studies that compile the relationship between radiography and DM in the literature is limited. Eymard et al. (21) investigated the effect of diabetes on joint space narrowing in the medial tibiofemoral joint (EAD) in 559 patients. However, radiographic changes may be related to the treatment of diabetic patients. Khaled El Jarallah et al. (22) included 99 type 2 diabetic patients who did not receive insulin therapy, 112 diabetic patients receiving insulin therapy and 100 patients with non-diabetic gonarthrosis and compared

the radiographs. In the radiographs of the group receiving insulin therapy, less osteophyte formation was detected. Horn et al. (23) also compared radiographs of 25 diabetic female patients and 48 non-diabetic gonarthrosis patients. In this study, lesser osteophyte formation was detected in diabetic group radiography. In our study, while 38 (84.4%) patients in the diabetic group had grade 3-4 according to the Kellgren-Lawrence (KLS) classification, 14 (37.8%) patients in the control group had grade 3-4 gonarthrosis. Moreover, the detection of osteophyte formation more than the control group may be related to the patients who did not receive insulin therapy as a treatment. Because insulin has been shown to reduce chondrogenesis and osteogenesis required for osteophyte formation at the cellular level (24).

There are many studies compiling the relationship between knee OA and quadriceps muscle strength. Shigeru et al. (25) evaluated 976 knee muscle strength with a quadriceps training machine (QTM-05F, Alcare Co.). As a result, they determined that quadriceps muscle weakness was a risk factor in increasing the incidence of radiographic knee OA, but it was not effective in progression. In literature, patients diagnosed with OA radiographically had a lower quadriceps muscle strength compared to patients without OA. Another study reported that the quadriceps muscle strength of patients diagnosed as gonarthrosis radiographically was 22% lower compared to patients who were not diagnosed as OA radiographically (27). In our study, quadriceps muscle strength was evaluated with manual muscle strength. Muscle strength was less than 5/5 in 36 (80.6%) patients in the case group and 10 (27%) patients in the control group. However, unlike the two studies above, the control group was also diagnosed with gonarthrosis in our study. Therefore, the effect of radiographic OA on quadriceps muscle strength could not be determined. In addition, since the muscle strength measurement sensitivity was performed with low manual muscle strength, the difference in muscle strength or loss between the case and the control group could not be measured objectively. Therefore, the lack of quadriceps muscle strength with a sensitive device is one of the biggest limitations of our study.

There are studies evaluating knee function and quality of life in diabetic patients. Annet Eitner et al. (28) performed and compared the KOOS test in 23 diabetic and 47 non-diabetic patients. There was a statistically significant difference between the two groups. Moreover, a statistically significant relationship was detected between HbA1c and KOOS test (28). Baldwin et al. (29) on the other hand, the KOOS test was found to be correlated with the limitation of joint range of motion. Elena Zonova and colleagues (30) compared 52 patients with diabetic OA and 28 patients in terms of pain, quality of life, WOMAC total index and SF-36. As a result, a numerically significant difference was found between the indices between the two groups. Antje Miksch et al. (31) reported that diabetic patients with group OA had numerically low scores in the components of the SF-36 test when compared to diabetic patients with hypertension. In our study, the pain and function components of SF-36, WOMAC and KOOS, were different, similar to the results of the above study. In addition, it was observed in our study that Hb A1c and limitation of joint range of motion in the knee were correlated with the KOOS test.

Diabetic patients have limited activities of daily living compared to healthy controls. There are many studies on this subject (32). Eriksson et al. (33) reported that diabetic patients had 10% lower vital capacity with V02 max and 16% lower physical activity compared to healthy control. An important reason for the low capacity of life activities of diabetic patients may be that axonal loss causes muscle atrophy. Anderson et al. (34) found that a significant reduction in strength in tibialis anterior and quadriceps muscles due to axonal loss. In our study, the FAS was below 5 in 32 diabetic patients (71.1%). There was a statistically significant difference between the two groups in the comparison of the control group and FAS. In addition, 61% of our patients had polyneuropathy. Therefore, the loss of muscle strength in the quadriceps and tibialis anterior due to axonal loss, decreased physical function capacity, may explain the statistical difference in our study.

Although the relationship between DM and knee OA was shown in our study, prospective studies are needed to confirm this situation. Therefore, the cross-sectional nature of our study is an important limitation. But the biggest limitation of our study is to evaluate quadriceps muscle strength with low sensitivity and manual muscle strength. Because the loss of muscle strength in the case group could not be clarified.

CONCLUSION

DM has a negative effect on quality of life and activities of life in knee OA. It is critical to question DM in those diagnosed with OA in rehabilitation clinics.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Ankara Training and Research Hospital Noninvasive Clinical Ethics Committee (Date: 02.22.2017, Decision No:46).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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