

Buckling in the Iranian Patients with Knee Osteoarthritis: Its Frequency and Correlation with Physical Activities and Falling

Azar Moezy, Ph.D. ¹, Zahra Aliyari, M.D. ², Sahar Kavand M.D. ³

1- Associate Professor, Sports Medicine Department, Iran University of Medical Sciences, Tehran, Iran (Corresponding author; E-mail: moezy.a@iums.ac.ir)

2- M.D. Iran University of Medical Sciences, Tehran, Iran

3- Assistant of Sports Medicine, Sports Medicine Department, Iran University of Medical Sciences, Tehran, Iran

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Abstract

Introduction: Knee osteoarthritis (KOA), one of the most common articular diseases, sometimes leads to severe disability. This study aimed to estimate the prevalence of knee-buckling in patients with KOA during the past three months and to investigate its relation with the physical function.

Methods: A cross-sectional study was performed on 190 patients with KOA. Two checklists and WOMAC questionnaire were completed by the participants. The patients' function was evaluated by timed up and go (TUG) and six-minute walk tests (6MWT). Comparison between the two groups of patients with and without buckling was done using independent t-test and the correlations were analyzed between the variables using K square and Pearson correlation tests.

Results: Eighty three patients (43.68%) had a history of buckling in the past 3 months. Knee-buckling frequency was 40.87% and 48% in women and men, respectively. Statistical analysis showed significant differences between pain ($p = 0.007$), TUG ($p = 0.0001$), 6MWT ($p = 0.0001$), WOMAC pain ($p = 0.005$), WOMAC stiffness ($p = 0.006$) and total WOMAC scores ($p = 0.03$) concerning the two groups with and without buckling. There was a significant correlation between buckling with gender ($\rho = 0.72$, $p = 0.025$), KOA history ($\rho = 0.67$, $p = 0.033$) and the rate of fall ($\rho = 0.87$, $p = 0.012$). Moreover, there were reverse significant correlations between the history of buckling with WOMAC score ($r = -0.51$, $p = 0.02$) and the functional tests results including TUG ($r = -0.57$, $p = 0.0001$) and 6MWT ($r = -0.67$, $p = 0.0001$).

Conclusion: The results indicated a prevalence of 43.68% buckling among the patients which was associated with their functional impairment.

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Introduction

Knee Osteoarthritis (KOA), the most common degenerative osteoarticular disease, is characterized by arthralgia, stiffness, decreased quadriceps strength and functional disability. Recently, the sensation of knee instability

was also reported by the patients with KOA during activities of daily living (1).

The sudden loss of knee stability at the time of weight bearing is a condition called knee-buckling, shifting, or giving-way (2,3). Buckling, as an important issue in orthopedic

literature (4), occurs mostly in persons with knee pain and is seen as evidence of an internal derangement (5).

Unfortunately giving-way has been less considered and often neglected in the KOA despite its numerous complications. Mechanical instability and episodes of buckling may develop in patients with KOA even before activity-related pain (6). Knee instability has a great impact on the patients' performance and disrupts their quality of life (7,8). It has been reported that knee-buckling in KOA patients was significantly associated with the fear of falling, poor balance and physical function (9,10). Knee-buckling in patients with KOA increases the chance of fractures, including femoral neck fractures, because of bone density reduction in the elderly (11).

The development of KOA is associated with inability to stand and walk which is exacerbated by buckling (12). It is clear that the complications of knee instability impose a lot of health care costs on the health system. Furthermore, KOA with joint instability and motor disabilities affects the cardiorespiratory health and increases the incidence of cardiovascular diseases (13).

Unfortunately, the prevalence of buckling and its effect on physical function has not been studied in Iran. We sought to determine the frequency of knee-buckling in the past three months among the patients with KOA, their rate of fall and also its relationship with their function.

Materials and Methods

This was a cross-sectional study with ethical approval from the Research Ethics Committee of Iran University of Medical Sciences (IR.IUMS.REC 1395.8821215204) based on the latest version of the Declaration of Helsinki. This study was

carried out during 2016-2017 in the Sports Medicine Department, Iran University of Medical Sciences, Tehran, Iran.

Participants

Participants were 190 people (115 women, 75 men) who had been diagnosed with tibiofemoral and/or patellofemoral osteoarthritis. Patients were initially recruited through the notices in university hospitals in Tehran.

For definitive diagnosis of KOA, the patients underwent an orthopedic specialist examination. Participants were included if they had grade II or III Kellgren and Lawrence (K-L) radiographic changes from standing bent posterior-anterior view, lateral view, and sunrise view radiographs. If a participant had bilateral KOA that fitted the criteria, the more painful knee was used in the study.

The inclusion criteria were as follows: (1) X-ray stages II and III osteoarthritis according to the criteria proposed by K-L; (2) age between 50-65 years; (3) BMI \leq 30; (4) Knee pain lasted for at least 6 months with the minimum intensity of 3 on VAS scale in activities such as going up and down stairs, sitting and squat; (5) no history of acute traumatic injuries; (6) no history of previous surgery or injury in the knee and lower extremities; (7) lack of neuromuscular diseases; (8) normal mental state; (9) absence of bone implants; (10) no history of new fractures; (11) lack of cancerous tumors and (12) no history of chronic diseases and any condition that affects the study. The exclusion criteria were (1) unwillingness to participate in the study; (2) uncompleted evaluation and (3) any damage to the knee joint during the study.

Sample size: According to Fitzgerald et al. (14) who estimated the prevalence of knee buckling in KOA patients at 63% and assuming a power of 80%, $\alpha=0.05$, and an accuracy

of 0.01, the sample size in the present study was determined to be 190 patients.

The patients were included in the study using convenience sampling and all of them signed a written consent form prior to participation and also completed demographic data sheets. All patients were allowed to be excluded at any time, if they did not want to continue the study. Two hundred and twelve patients were enrolled into the study; 22 subjects did not fulfill the inclusion criteria; thus, the main participants were 190 patients.

Basic testing procedure

At first, a demographic and health history checklist was completed by the patients. A self-reported knee instability checklist, based on the study of Felson et al. (2), was used to appraise the episodes of buckling in the past 3 months. Patients reporting buckling were additionally asked for the number of buckling in the previous 3 months; whether these episodes concerned the left, right, or both knees and whether knee-buckling had resulted in a fall or not. Moreover, we asked what they were doing when their knee buckled and wrote the name of the activity. Outcome measures consisted of knee pain intensity by Visual Analogue Scale (VAS), timed up and go test (TUG) (15), and six-minute walk test (6MWT) (15). Three trails of TUG and 6MWT tests were used for assessment of the performance and its mean was recorded for the patients.

To evaluate the effect of buckling on physical function, we used Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) as a self-reported questionnaire consisting of 24 items divided into 3 subscales; Pain (5 items), Stiffness (2 items), and Physical Function (17

items). Each item is scored on a scale of 0 to 4 on the basis of the amount of difficulty experienced. The total score ranges from 0 to 96 (16). Ebrahimzadeh et al. assessed the validity and reliability of WOMAC questionnaire and demonstrated its suitability for Persian-speaking patients with KOA (16).

Statistical Analysis

The SPSS software (version 23; SPSS Inc., Chicago, IL, USA) was used to conduct the analysis. Descriptive results were presented as mean \pm SD for quantitative variables and frequency (percentage) for categorical variables. Data normality was assessed using the Kolmogorov-Smirnov test. The between-group comparison was analyzed by independent t-test; in addition the correlation between variables was analyzed using K square and Pearson tests. The P-value was also set at less than 0.05.

Results

A total of 190 patients, 115 women and 75 men, participated in this study and completed the assessments. The demographic data and characteristics of patients as well as the prevalence of knee-buckling are depicted in tables 1 and 2. Overall, eighty three patients (43.68%) out of 190 participants had the history of buckling (47 in women and 36 in men). The history of KOA in all patients was 8.33 ± 5.5 years. Among patients with buckling, the history of KOA was 11.8 ± 2.5 years, whereas in patients without buckling, the history was estimated to be 6.45 ± 3.1 years.

Table 1. Descriptive statistics for the characteristics of participants (n=190)

	WOMEN (N=115)	MEN (N=75)
	MEAN ± SD	MEAN ± SD
AGE (YEAR)	56.5±8.5	65.5±4.5
WEIGHT(KG)	74.72±10.12	74.52±8.77
HEIGHT(CM)	159.4±5.06	164.88±4.27
BODY MASS INDEX (KG/M2)	29.39±3.54	25.66±7.75
VAS (0-10)	4.5 ± 2.1	5.00 ±1.91

Table 2. The characteristics of participants (n=190) and the prevalence of knee buckling

	Women (N=115)	Men (N=75)
Kellgren–Lawrence Grade of Tibiofemoral		
Grade 2	68 (59.13%)	57(76.00%)
Grade 3	47 (40.87%)	18(24.00%)
Patellofemoral Osteoarthritis		
Absent	61 (53.04%)	34 (45.33%)
Present	54 (46.96%)	41 (54.67%)
With Knee Buckling	47(40.87%)	36 (48.00%)
Right Knee	25(53.19%)	20(55.56%)
Left Knee	14 (29.79%)	11(30.56%)
Both Knees	^ (17.02%)	5(13.88%)
Without Knee Buckling	68 (59.13%)	39 (52.00%)

Thirty-five patients (19 women and 16 men) (42.17%) out of 83 participants with buckling mentioned a history of falls due to the giving-way during the past three months and interestingly all of them experienced falling more than 2 times in this period.

The total rate of experiencing buckling was 205 episodes (90 in women and 115 in men) in the patients. The status in

which the buckling was occurred is listed in Table 3. The most common activity for buckling was walking in both genders without any significant differences in the status of occurring between men and women except in knee twisting or turning (Table 3).

Table 3. The activities reported at the time of buckling episodes

	Total episode of the buckling (n=205) No. (%)	Women (n=90) No. (%)	Men (n=115) No. (%)	P value (P ≤ 0.05)
Walking	53(25.85%)	23(25.56%)	30(26.09%)	0.29
Rising from a chair	31(15.12%)	15(16.67%)	16(13.91%)	0.62
Sitting down in a chair	22(10.73%)	10(11.11%)	12(10.43%)	0.35
Going up stairs	30(14.63%)	13(14.44%)	17(14.78%)	0.57
Going down stairs	24(11.71%)	11(12.22%)	13(11.30%)	0.85
Twisting or Turning	24(11.71%)	8(8.89%)	16(13.91%)	0.03*
Others	21(10.24%)	10(11.11%)	11(9.57%)	0.43

*Significant difference

The mean of VAS, BMI, functional tests, and the score of WOMAC questionnaire compared in patients with and without the buckling is shown in Table 4. Independent t-test showed

significant differences in VAS, functional tests, the score of pain and function subscales of the WOMAC as well as the overall score of the WOMAC questionnaire (Table 4).

Table 4. Comparison between two groups of the patients with or without the history of knee buckling

	With knee buckling (n=83) Mean ± SD	Without knee buckling (n=107) Mean ± SD	P value (P ≤ 0.05)
VAS (0-10)	6.6 ± 1.5	4.5 ± 0.81	0.007*
BMI(kg/m ²)	28.25 ± 3.25	26.87 ± 4.37	0.28
TUG (sec)	11.7 ± 0.74	8.87 ± 0.68	0.0001*
6MWT (m)	289.7 ± 22.11	357.14 ± 23.8	0.0001*
WOMAC pain subscale	9.2 ± 0.8	7.6 ± 0.7	0.005*
WOMAC stiffness subscale	3.9 ± 0.7	2.8 ± 0.90	0.069
WOMAC function subscale	33.6 ± 2.9	32.8 ± 2.1	0.006*
WOMAC total score	46.7 ± 4.3	46.7 ± 4.3	0.03*

*Significant difference

Buckling was more common in knees with both involvements of tibiofemoral and patellofemoral (57.83%) than in those with the involvement of each tibiofemoral (30.12%) and patellofemoral (12.05%) joints alone. The prevalence of buckling was 59.12% among patients with knee pain graded more than 4 based on the VAS and 40.88% among those with

pain less than 4. Also, patients with knee-buckling had a higher WOMAC disability score than those without it.

K square test showed a significant relationship between the buckling and female gender ($p=0.027$, $\rho=0.225$), however, there was no significant correlation between the buckling and BMI as well as age in the patients ($p=0.185$, $\rho=0.000$ and $p=0.341$, $\rho=0.021$, respectively). A significant correlation was

also observed between the buckling and KOA history ($p= 0.033$, $\rho= 0.67$) using K square test. Furthermore, knee-buckling was correlated with the involvement of both tibiofemoral and patellofemoral joints ($p = 0.019$, $\rho = 0.825$) and higher VAS values ($p= 0.029$, $\rho = 0.763$).

There was a positive correlation between the buckling and the number of falls in the patients ($p = 0.02$, $\rho= 0.87$). Based on the Pearson test, there was a correlation between buckling and functional tests outcomes. In this regard, functional tests results were worse in the patients with the buckling, the values of p and r for TUG test and the 6MWT were $p = 0.0001$, $r = -0.57$ test and $p = 0.0001$, $r = -0.67$, respectively. Furthermore, an inverse correlation was observed between the buckling and the total WOMAC score ($p = 0.02$, $r = -0.51$) as well as the WOMAC pain ($p = 0.032$, $r = -0.43$) and function ($p = 0.004$, $r = -0.43$) subscales.

Discussion

The present study was conducted for the first time in Iran to estimate the prevalence of knee-buckling in KOA patients. In addition, we studied the correlation of knee-buckling with some characteristic of KOA such as pain, history of KOA and etc. The results of the present study indicated a prevalence of 43.68% for knee-buckling among the patients. It was also found that a substantial number of patients with KOA had episodes of giving-way during daily activities which was an important limiting factor in their performances.

According to a study by Fitzgerald et al., the prevalence of knee-buckling was estimated at 63% in KOA patients (3). Felson et al. also reported the incidence of the buckling in patients who experienced it once (11.8%) in the past three months in comparison to the patients who experienced it more

than once (78.1%) in the same period (2). Comparing the results of these two studies, the prevalence of buckling in the study conducted by Felson et al. was far more than the prevalence of the current study (2). This difference can be owing to the type of Felson's study which was a cohort and lasted for three years, while the present study was a cross-sectional one that was conducted over a 12-month period (2). Nguyen et al. determined the buckling prevalence at 18% over the past three months in patients with KOA (9) which was less than our study. The sample size of their study was far more than ours, but the characteristics of their participants such as BMI, the history of KOAs, grade of osteoarthritis and VAS were the same. They evaluated knee buckling, knee instability sensation without buckling and a combination of knee buckling and instability, whereas the knee buckling was just considered in the present study.

The activities reported by the patients at the time of buckling according to the number of occurrences were walking, going up and down stairs, knee twisting or turning. These activities and others in the present study were exactly similar to the findings of the studies conducted by Felson et al. (2), Fitzgerald et al. (3) and Knoop et al. (4). Buckling, which is a sudden loss of postural support on the knee, usually occurs when weight-bearing demands are increased. Many patients who have experienced repeated buckling often use a kind of support, such as a cane while walking, to avoid falling and other serious consequences.

Our findings revealed a higher VAS, lower scores for functional tests, and lower scores for pain and function subscales as well as the overall score of the WOMAC in the patients with knee-buckling. It seems that the sudden giving-way could occur because of severe pain or insufficient muscle

strength to support body weight (2-4,9,11). In spite of our findings, which showed a positive correlation between higher VAS and the buckling, there was not any relation between pain and knee-buckling in the study conducted by Felson et al. (2). Our findings, on the other hand, were in line with the results of the study done by van der Esch et al. which demonstrated that the buckling was strongly associated with an increase in pain (17). Obviously, knee pain has an inhibitory effect on the contraction of quadriceps femoris and causes muscle atrophy and weakness over time (18,19). Since the muscle has a great impact on knee stability; the development of its weakness may lead to giving-way (20).

Contrary to our findings, there was no significant relation between the buckling and female gender in the study conducted by van der Esch et al. (17). It may be due to the weakness of the quadriceps femoris of the women. According to Slemenda et al. (21), Palmieri-Smith et al. (22) and Segal et al. (23), there was a significant decrease in quadriceps femoris strength in the women with KOA which has a significant effect on joint stability. But since the strength of quadriceps has not been evaluated in this study, we cannot provide such a reason for reduction of knee stability.

Felson et al. also estimated the rate of falls at 12.6% in the last three months (2), while this rate in our study was 42.17% over the same period which was almost three times more than the results of the study done by Felson et al. The reason for this might be because of the lower age of the patients in their study. Other reasons can be related to more muscular weakness or more severe pain or uneven levels of walking in the community. Fortunately, there was no serious lesion due to the falls requiring hospitalization in the studied patients.

In the present study, all patients experienced the buckling more than 2 times in the past three months which was similar to the study undertaken by Felson et al. (2). The history of buckling in the right knee was higher than the left knee, however, 30.9% of the patients had a history of knee-buckling on both knees. In none of the existing studies, the prevalence of buckling was taken into consideration based on the knee side.

According to the assumptions of the research, it seems that there should be a correlation between an increase in BMI and the buckling, while our results did not show such a correlation similar to the findings of the study conducted by van der Esch et al. (17). Therefore, an increase in BMI may be considered as a risk factor for the development of KOA (24,25); but the results of our study did not reveal any evidence for the occurrence of buckling due to high BMI.

Nevertheless, there was a significant correlation between knee-buckling and the history of KOA. This finding is consistent with the results of the study done by Felson et al. (2). On the contrary, the findings obtained from the study by Schmitt et al. showed no significant relation between the buckling and the history of KOA (7). Similar to the results of the studies by Schmitt et al. and van der Esch et al. (17), no significant correlation was observed between buckling and the history of KOA. It seems that a long history of KOA is often associated with more and more pain, increasing of muscle weakness, decreasing of dynamic stabilization and enhancement of knee-buckling episodes.

One of the notable points in our findings was a positive correlation between knee-buckling and increasing of fall rates in the patients. In other words, the patients with knee-buckling mentioned a greater number of falls during the past three months. Since most of the patients were elderly, a fall can lead

to fractures, soft tissue damage, bruising, subarachnoid hematoma as well as fear of falling, inability to work, loss of self-esteem, anxiety, depression, dependence, a decrease in the quality of life, etc. (26-28). Elderly KOA patients due to reduced muscle strength, decreased neuromuscular control and balance dysfunction are at a greater risk of falling, which requires interventions to prevent their falling (29,30).

The patients with buckling obtained lower scores in the functional tests which indicated a reverse correlation between tests' results and knee-buckling. By the same token, Nguyen et al.(9) and Sharma et al.(10) observed positive correlations between the buckling and impaired physical function in the patients with KOA (9). This finding may be attributed to increased knee pain, decreased muscle strength and endurance, reduced proprioception efficiency, muscle atrophy as well as fear of falling (2,11,15,18,23,26,27,29,31,32).

Furthermore, reverse correlations were revealed between the buckling and total WOMAC scores as well as WOMAC pain and function subscales. The scores of WOMAC and its subscales showed a greater decrease in patients with knee-buckling, which was in line with the findings of the studies by Felson et al. (2), Schmitt et al. (7), Nguyen et al. (9) and Sharma et al. (10). KOA symptoms such as pain, effusion, muscle weakness, functional disability and joint instability are among the most common factors which are effective in reducing WOMAC scores.

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The most important limitations of this study may be its small sample size, lack of sufficient studies in Iran to compare the results and also failure to check all risk factors associated with knee-buckling. Therefore, conducting similar studies with higher sample sizes, considering other factors related to giving-way, studying knee-buckling in patients with secondary KOA can promote our knowledge in this field.

Conclusion

The findings demonstrated a prevalence of 43.68% for knee-buckling in patients with KOA. There were also significant differences in VAS, results of functional tests and the score of the WOMAC questionnaire and its subscale between the patients with and without the history of knee-buckling. Moreover, there was a significant correlation between knee-buckling and female gender, history of KOA, and patients fall. In conclusion, based on our findings, it is recommended that enough consideration be taken for KOA patients with buckling in order to reduce the chance of the fall occurrence.

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