

# Analyzing the History of Falls in Patients with Severe Knee Osteoarthritis

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**Background:** One out of three adults over the age of 65 years and one out of two over the age of 80 falls annually. Fall risk increases for older adults with severe knee osteoarthritis, a matter that should be further researched. The main purpose of this study was to investigate the history of falls including frequency, mechanism and location of falls, activity during falling and injuries sustained from falls examining at the same time their physical status. The secondary purpose was to determine the effect of age, gender, chronic diseases, social environment, pain elsewhere in the body and components of health related quality of life such as pain, stiffness, physical function, and dynamic stability on falls frequency in older adults aged 65 years and older with severe knee osteoarthritis.

**Methods:** An observational longitudinal study was conducted on 68 patients (11 males and 57 females) scheduled for total knee replacement due to severe knee osteoarthritis (grade 3 or 4) and knee pain lasting at least one year or more. Patients were personally interviewed for fall history and asked to complete self-administered questionnaires, such as the 36-item Short Form Health Survey (SF-36) and the Western Ontario and McMaster Universities Arthritis Index (WOMAC), and physical performance test was performed.

**Results:** The frequency of falls was 63.2% for the past year. The majority of falls took place during walking (89.23%). The main cause of falling was stumbling (41.54%). There was a high rate of injurious falling (29.3%). The time patients needed to complete the physical performance test implied the presence of disability and frailty. The high rates of fall risk, the high disability levels, and the low quality of life were confirmed by questionnaires and the mobility test.

**Conclusions:** Patients with severe knee osteoarthritis were at greater risk of falling, as compared to healthy older adults. Pain, stiffness, limited physical ability, reduced muscle strength, all consequences of severe knee osteoarthritis, restricted patient's quality of life and increased the fall risk. Therefore, patients with severe knee osteoarthritis should not postpone having total knee replacement, since it was clear that they would face more complicated matters when combining with fractures other serious injuries and disability.

**Keywords:** *Knee osteoarthritis, Falls, Fall risk, Quality of life*

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Falls in the elderly have become a serious problem and are major contributors to functional decline and health care utilization. One out of three adults over the age of 65 years falls annually and half of these individuals experience multiple falls.<sup>1)</sup> Additionally at the age of 80 years, the percentage reaches one out of two annually.<sup>2)</sup>

Knee osteoarthritis (OA) is a painful, chronic degenerative joint disorder affecting a large portion of the older population worldwide,<sup>3)</sup> the largest source of physical disability in the USA<sup>4)</sup> and the joint most commonly affected by OA is the knee.<sup>5)</sup> Severe pain, a hallmark symptom of knee OA, is also a major predisposing factor for increased fall risk.<sup>6-8)</sup> Women with wide spread musculoskeletal pain have 66% increased fall risk than those with no pain or mild pain.<sup>9)</sup> Functionally, pain may negatively influence muscle strength, coordination, postural sway, power, and proprioception, factors that further increase the risk of falls.<sup>10)</sup> Simultaneously, pain and neuromuscular deficits in strength, balance and proprioception associated with knee OA, contribute to an increased risk of falling in this population.<sup>9-12)</sup>

Although knee OA is a risk factor for falling and one of the leading causes of disability in the elderly, little is known about the occurrence and frequency of falls, the nature, the circumstances and injuries resulting from falls in patient with severe knee OA, focusing particularly on musculoskeletal problems caused by OA. We assume that the frequency of falls in patients with severe knee OA would be higher than the 30% generally attributed to community dwelling older adults, since those patients gather many risk factors such as older age, pain, impaired mobility and low quality of life. Therefore, the main purpose of this study was to investigate the history of falls including falls frequency, mechanism and location of falls, activity during falling and injuries sustained from falls reported, and examination of physical status. A secondary purpose was to determine the effect of age, gender, chronic diseases, social environment, pain elsewhere in the body and components of health related quality of life such as pain, stiffness, physical function, and dynamic stability on falls frequency in older adults aged 65 years and older with severe knee OA.

## METHOD

### Patients

Patients with severe knee OA grade 3 and 4<sup>13)</sup> and knee pain for at least a year or more were included in the study. Excluded patients were those suffering from cognitive impairment (1 patient), Parkinson disease (3 patients),

patients with rheumatoid arthritis (RA, 9 patients), and 11 patients with knee OA (either not being at grade 3 and 4 classification, or not having knee pain for at least a year). Overall, 68 out of 92 participants (11 males and 57 females) aged 65 years and older ( $73.00 \pm 5.28$  years) and body mass index (BMI,  $30.36 \pm 4.49$  kg/m<sup>2</sup>), were recruited in the Orthopedic Department of Sismanoglio-Amalia Fleming General Hospital in Athens with severe knee OA grade 3 and 4<sup>14)</sup> and knee pain for at least a year or more, in a waiting list for total knee replacement (TKR) from September 2010 to September 2011. Patients were personally interviewed for fall history, completed self-administered questionnaires and assessed in physical performance test. All patients agreed to participate in this study and signed a written informed consent. The study was approved by the medical council of the hospital and the Ethics Committee.

### Fall History

A fall was defined as unintentionally coming to rest on the ground, or at some other lower level, not as a result of a major intrinsic event such as a faint or stroke, seizure, or an overwhelming external hazard like hit by a vehicle.<sup>15)</sup> This definition is appropriate for the present study as it identifies factors that impair the sensorimotor function and balance control, whereas a broader definition is appropriate for studies that also address cardiovascular causes of falls. Patients were personally interviewed for falls history in the last year, frequency of falls (non-fallers, 1-time fallers, and frequent fallers), location of falls (indoor, outdoor), mechanism or causes of falls (tripped, slipped, lost balance, muscle weakness, and missed curb or step), activity during fall (walking, climbing stairs, trying to reach something, and moving from and to a chair or bed), and reported injuries sustained from falls (no injury, no fracture but other injuries, fracture).

### Self-Administered Questionnaires

#### Quality of life

The 36-item Short Form Health Survey (SF-36), one of the most widely used generic health-related quality of life (HRQoL) instruments worldwide, evaluates the physical and the mental health of the elderly, combining physical, mental and social affections of the illness. It is very subjective according to someone's life.<sup>16)</sup> It includes 36 questions in total that estimate 8 units: physical function, social behavior, physical role, bodily pain, mental health, emotional role, vitality, and general health, with higher scores (range, 0 to 100) reflecting better perceived health.<sup>17)</sup>

### Western Ontario and McMaster Universities Arthritis Index

The Western Ontario and McMaster Universities Arthritis Index (WOMAC) is a 24-item questionnaire with 3 subscales measuring: pain (5 items), stiffness (2 items) and physical function (17 items). A lower score indicates a better outcome. Numerous validation studies have been conducted using the WOMAC.<sup>11)</sup> It has also been used to evaluate many knee OA interventions, both surgical and conservative.<sup>18)</sup>

### Physical Performance Test

#### Turn up and go test

Turn up and go (TUG) test measures the time it takes for a patient to rise from an armed chair (seat height of 46 cm), walk 3 m, turn and return to sitting in the same chair. Subjects were instructed to walk as quickly as they feel safe and comfortable. The use of the arms of the chair was permitted to stand up and sit down. The TUG test is a simple test used to assess a person's mobility and requires both static and dynamic stability.<sup>14)</sup> The TUG test was found to be a sensitive (sensitivity, 87%) and specific (specificity, 87%) measure for identifying elderly individuals who are prone to falls.<sup>19)</sup>

### Statistical analysis

Data collection for patients with severe knee OA included demographic information (age, gender, and social environment), clinical characteristics (falling status, BMI, chronic diseases, pain elsewhere in the body, and other arthroplasty), scores in self report instruments (WOMAC, SF-36), and physical performance test (TUG test). Data were expressed as mean  $\pm$  standard deviation or median (in case of violation of normality) for continuous variables and as percentages for categorical data. The Kolmogorov-Smirnov test was utilized for normality analysis of the parameters. All tests were two-sided, and statistical significance was set at  $p < 0.05$ . All analyses were carried out using the SPSS ver. 17.0 (SPSS Inc., Chicago, IL, USA).

Unifactorial analyses were made by using the chi-square test or alternatively the Fisher exact test to analyze the relation between the outcome variable (presence or absence of falls) and the qualitative variables, whereas the Student *t*-test or Mann-Whitney *U*-test and one-way ANOVA or Kruskal-Wallis were used to analyze the relation between the outcome variable and the quantitative measures respectively.

## RESULTS

According to frequency analysis, 63.2% of the sample had

Table 1. Baseline Demographic and Clinical Characteristics of Participants (n = 68)

Characteristic	Value
Age (yr)	73.00 $\pm$ 5.28
Gender	
Male	11 (16.2)
Female	57 (83.8)
Social environment	
Yes	58 (85.3)
No	10 (14.7)
Body mass index (kg/m <sup>2</sup> )	30.36 $\pm$ 4.49
Chronic diseases	
0	4 (5.9)
1	24 (35.3)
2	32 (47.1)
3	8 (11.8)
Pain elsewhere in the body	
Yes	22 (32.4)
No	46 (67.6)
Other arthroplasty	
Yes	12 (17.6)
No	56 (82.32)
Frequency of falls	
Yes	43 (63.2)
No	25 (36.8)

Values are presented as mean  $\pm$  standard deviation or number (%).

at least 1 fall in the past year, and 43 patients had 65 falls. Among fallers, 20 of them (29.4%) were one time fallers and 23 (33.8%) were frequent fallers. The demographic and clinical characteristics of the participants were described in Table 1. The characteristics of the falls that participants in this study experienced throughout the period of a year were presented in Table 2. Stumbling was the main cause of falling, followed by muscle weakness, slipping, loss of balancing and missing step was among other causes of falls. Ambulating is the most common activity in which most falls have happened and the location of most falls was outdoors. According to the results of analysis of variance (Tables 3 and 4), none of the factors including

Table 2. Characteristics of Falls (n = 65) of the Participants

Characteristic of falls	No. (%)
Injuries during falling	
Fracture	4 (6.15)
Minor injury	15 (23.08)
No injury	46 (70.77)
Mechanism of falls	
Stumble-triple	27 (41.54)
Slip	14 (21.54)
Lost balance	3 (4.61)
Missing steps	1 (1.54)
Muscle weakness	20 (30.77)
Activity during falling	
Ambulating	58 (89.23)
Stair climbing	5 (7.69)
Reaching for something	1 (1.54)
Getting up or down from bed or chair	1 (1.54)
Location of falls	
Indoor	16 (24.62)
Outdoor	49 (75.38)

demographic, clinical, or parameters of questionnaires had a significant effect on falling status. Low levels in quality of life of people with knee OA, were impressed on SF-36 questionnaire and high ranges of pain and stiffness as well as low levels of function, were impressed by WOMAC questionnaire (Table 5).

## DISCUSSION

According to the results, patients with severe knee OA not only were at greater risk of falling, as compared to falls in healthy older adults,<sup>1,2)</sup> but the risk was almost twice as high. In our study, the frequency of falls was 63.2% (43 out of 68 patients had 65 falls), a number that was higher than others, who had examined the same sample of patients.<sup>7,20-22)</sup> Furthermore, this result would have been even bigger, since we focused in falls caused by musculoskeletal problems and excluded falls due to other intrinsic events or external hazards. This finding may have been due to the fact that most of our patients were suffering from severe knee OA and most of them had the highest levels of pain,

Table 3. Unifactorial Qualitative Analysis of Falling Status

Variable	Patients with severe knee osteoarthritis		p-value
	Falling status (no)	Falling status (yes)	
Gender			0.102
Male	7 (28.0)	4 (9.3)	
Female	18 (72.0)	39 (90.7)	
Pain elsewhere in the body			0.789
No	16 (64.0)	30 (69.8)	
Yes	9 (36.0)	13 (30.2)	
Chronic diseases			< 0.999
1	10 (40.0)	18 (41.9)	
2 or 3	15 (60.0)	25 (58.1)	
Social environment			0.468
No	2 (8.0)	7 (16.3)	
Yes	23 (92.0)	36 (83.7)	
Other arthroplasty			0.751
No	20 (80.0)	35 (83.5)	
Yes	5 (20.0)	7 (16.7)	

Values are presented as number (%).

stiffness and dysfunction, which made them more vulnerable to instability, muscle weakness and finally falls.<sup>8)</sup> Additionally, there was no factor including demographic, clinical, or parameters of questionnaires that had a significant effect on falling status. This finding could explain the high rate of fall frequency, since the majority of patients were at high risk of falling, considering most of fall risk factors such as older age, pain, the presence of OA, impaired mobility, and low quality of life.<sup>23)</sup>

Similar results to ours were found only in the study of Williams et al.,<sup>24)</sup> reporting 64% of falls in 39 women with lower-limb OA or lower-limb rheumatoid arthritis in the preceding 12 months. Levinger et al.<sup>20)</sup> examined the frequency of falls of any kind in 35 patients with knee OA, and reported that the number of falls preoperatively was 48.5%. In the study of Delbaere et al.,<sup>25)</sup> absolute fall risk of older adults ranged from 11% for those with no risk factors, to nearly 55% for those who had multiple risk factors. In the study of Leveille et al.,<sup>9)</sup> the incidence of falls in 749 elderly patients with chronic musculoskeletal pain who had at least 1 fall in an 18-month observational period was 55%.

Table 4. Unifactorial Quantitative Analysis of Falling Status

Falling status	Mean ± SD	p-value
Age (yr)		0.965
No	72.96 ± 6.20	
Yes	73.02 ± 4.74	
Body mass index (kg/m <sup>2</sup> )		0.783
No	30.15 ± 4.74	
Yes	30.47 ± 4.34	
SF-36 <sub>PCS</sub>		0.734
No	34.88 ± 7.20	
Yes	34.28 ± 6.94	
SF-36 <sub>MCS</sub>		0.787
No	36.79 ± 7.31	
Yes	36.11 ± 11.11	
WOMAC pain		0.338
No	213.00 ± 84.20	
Yes	233.72 ± 85.89	
WOMAC stiffness		0.605
No	53.00 ± 47.50	
Yes	58.72 ± 41.51	
WOMAC physical function		0.882
No	549.00 ± 303.67	
Yes	539.53 ± 218.30	
Turn up and go test		0.603
No	13.39 ± 5.24	
Yes	12.85 ± 3.38	

SD: standard deviation, SF-36: 36-item Short Form Health Survey, PCS: physical component score, MCS: mental component score, WOMAC: Western Ontario and McMaster Universities Arthritis Index.

The majority of falls took place during walking (89.23%), using the stairs (7.69%), in order to reach something (1.54%), and getting in or out of a chair or bed (1.54%). The ability to walk normally depends on several bio-mechanical components. During walking, a person must bear 80% of his body weight on a single limb for 60% of the gait cycle. This equates to a loading force through the lower limb greater than four times the body weight.<sup>26)</sup> In order to compensate for the decreased ability to support load on one limb, especially the involved OA knee, older

Table 5. Total Score of Questionnaires in Patients with Severe Knee Osteoarthritis

Variable	Mean ± SD
SF-36 questionnaire	
Physical component score	34.50 ± 6.99
Mental component score	36.36 ± 9.83
WOMAC questionnaire	
Total	822.79 ± 317.31
Pain	226.10 ± 85.24
Stiffness	56.62 ± 43.54
Physical function	540.07 ± 255.18
Turn up and go physical performance test (sec)	13.05 ± 4.13

SF-36: 36-item Short Form Health Survey, WOMAC: Western Ontario and McMaster Universities Arthritis Index.

adults appear to increase double support time, shorten stride length, wide step width,<sup>27)</sup> and adopt a large postural sway.<sup>10)</sup> This compensation results in an abnormal gait, jeopardizing balance and increasing the fall risk. Hoops et al.<sup>12)</sup> suggested that people with lower extremity OA might be at an increased risk of becoming dynamically unstable and therefore less able to perform the appropriate compensatory step response. Inability to perform the stepping response during walking in the event of a trip or an oncoming obstacle, usually leads to a fall. This was confirmed in our study that showed that stumbling or tripping were the main causes of falls with 41.54% frequency.

In the literature, the most common cause of a fall in healthy older adults was tripping and slipping, which accounts for up to 60% of falls in adults over 65 years,<sup>28)</sup> a finding very similar to ours. In most cases, the obstacle that causes the trip is minor, but the adjustment, reaction speed and muscular strength and power needed to overcome a fall is too great for the individual to achieve.<sup>29)</sup> The literature does not indicate that older people as a group are more likely to trip than younger people; however, the likelihood of recovering from a trip is significantly lower in older adults.<sup>29)</sup> Other factors responsible for falls were muscle weakness (30.77%), lost balance (4.61%), and missed step (1.54%). Of these findings, the most unexpected was the high percentage of muscle weakness implying the lowest range of muscle strength, as well as the lack of any exercise program that would have reduced this deficit.

People with knee OA also have an increased risk of fracture. The increase in fracture risk may, in part, be due

to the increased incidence of falls and/or an increase in the severity of falls. Examining the consequences of the falls reported in our study, 70.77% of patients had no injuries due to a fall, 23.08% had at least a bruise or a muscle injury and 6.15% had a fracture (hip, elbow spine, and wrist). Consequently, injurious falls accounted for 29.23%, which was a high percentage, confirming that individuals with severe knee OA not only fell more often but also experienced more severe injuries. In contrast, studies suggest that in a community older adult population approximately 1 in 10 falls result in a serious injury, such as hip fracture, other fracture, subdural hematoma, other serious soft tissue injury, or head injury, of which 5% are fractures.<sup>15)</sup>

Indoor and outdoor falls is also a matter of interest since we found a paradox concerning the high rate of outdoor falls. We expected that most falls occur indoors since our patients avoid going outside due to the presence of pain and disability. This hypothesis is enhanced by the findings in the literature that indicate that outdoors falls occur in younger adults, male, better educated, white, with the sense of better health.<sup>30)</sup> On the contrary, outdoor falls in our study count for 75.38%.

Low levels in quality of life of people with knee OA have been reported by our study with score of  $34.5 \pm 6.99$  for physical component score and  $36.36 \pm 9.83$  for mental component score and likewise in other studies with a total score of SF-36, 28.8 units,<sup>31)</sup> and 29.6 units.<sup>32)</sup> When focusing on the physical component, the low rates on physical functioning in our study as a result of the negative effects of serious OA, were also reported in other studies with score of 34.3 units,<sup>33)</sup> and a score of 31.8 units.<sup>34)</sup> Those results made clear that quality of life was seriously disturbed and outweighed the quantity of life with regard to quality of life, which is not the demand for the elderly.<sup>35)</sup>

High ranges of pain and stiffness and low levels of function, all parameters of WOMAC questionnaire, reflect the disabilities that patients with severe knee OA experience. In our study, we determined a total score of  $822.79 \pm 317$  units, levels of pain at  $226.10 \pm 85.24$  units, levels of stiffness at  $56.62 \pm 43.54$  units and levels of physical function at  $540.07 \pm 255.18$ , similar to results from previous studies.<sup>20,22)</sup>

The results in TUG test showed that the time all patients needed to complete the task was  $> 13$  seconds that implied the presence of disability and frailty. Those results were similar to the 12.8 seconds in study of Arnold and Faulkner,<sup>21)</sup> who examined 105 patients with hip OA with hip pain for at least 6 months and frequency of falls at 45.3%, and even higher than  $9.6 \pm 2.4$  seconds reported by Mizner et al.<sup>36)</sup> According to the American College of

Rheumatology and Alberta Health Services,<sup>37)</sup> scores of  $\leq 10$  seconds indicate normal mobility, 11 to 20 seconds are within normal limits for frail elderly and disabled patients and  $> 20$  seconds means the person needs assistance outside and indicates further examination and intervention.

Despite the limitations of the study, we would identify the small number of patients because the research included only patients with severe knee OA, almost a month before their scheduled operation. Nevertheless, there are numerous studies examining falls for community living elderly population but there are only few examining patients with knee OA and even fewer including patients with severe knee OA. Another limitation of our study was that we did not include a control group but based the comparison on numerous studies describing the frequencies of falls concerning community living elderly population. Furthermore, although we tried to include several factors related to falls, it is known that elderly patients have a range of other health problems and therefore the frequency of falls may have been related to other factors that were not assessed in the current study. Also, we would like to mention that the study is retrospective and possibly patients may underestimate or overestimate their falling history. Despite these limitations, the clinical implication of the study results is that patients with severe knee OA have an increased risk of falls and their health status reduced significantly.

In conclusion, patients with severe knee OA were at greater risk of falling, as compared to healthy older adults. Consequences of severe knee OA including pain stiffness, limited physical ability, and reduced muscle strength, restricted patients' quality of life, increased the fall risk. Therefore, patients with severe knee OA should not postpone having TKR, since it was clear that they would face more complicated matters when combining with fractures, other serious injuries and disability.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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