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Content list available at: www.benthamopen.com/TOORTHJ/

DOI: 10.2174/1874325001610010522

RESEARCH ARTICLE

Reduction of Falls and Factors Affecting Falls a Year After Total Knee Arthroplasty in Elderly Patients with Severe Knee Osteoarthritis

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Received: April 18, 2016 Revised: May 29, 2016 Accepted: August 16, 2016

Abstract:

Background:

Total Knee Arthroplasty (TKA)[1] is a common surgical treatment for severe knee Osteoarthritis (OA)[2], which generally improves pain, physical function, quality of life and possibly fall risk. Fall risk increases for older adults with severe knee OA; however it has not been studied extensively whether this parameter is improved after TKA.

Objective:

To investigate: a) the history and frequency of falls, including mechanism or causes of falls, injuries sustained from falls reported, activity during falling and location of falls and, b) the factors affecting falls, a year after TKA in elderly patients with severe knee OA.

Patients and Method:

An observational prospective longitudinal study of 68 patients (11 males and 57 females) was conducted. The frequency of falls was recorded every month after knee replacement for a year period. A year after the TKA patients completed self-administered questionnaires (SF-36, Womac, FOF, ABC, PASE) and were assessed in physical performance tests (TUG and BBS).

Results:

There was significant improvement in falls frequency ($p<0.001$), differentiation of falling status to the benefit of non fallers ($p<0.001$) and risk of serious injuries ($p<0.001$). The factors that affected falling status was history of falls ($p<0.0005$), fear of falls ($p<0.017$) and advanced age, marginally ($p<0.097$).

Conclusion:

TKA generally improved a lot of aspects in patients' life. One of these was the reduction of fall risk, which always co-exists in this population and can cause devastating problems threatening the benefits of the procedure.

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[1] TKA: Total Knee Arthroplasty.

[2] OA: Osteoarthritis.

Keywords: Elderly, Falls, Health realted quality of life, Knee, Severe osteoarthritis, Total knee arthroplasty.

INTRODUCTION

Total Knee Arthroplasty (TKA) is a common surgical treatment for severe knee Osteoarthritis (OA); the most frequently performed joint arthroplasty, improving pain, physical function, disability and health related quality of life (HRQoL) [1 - 6]. Key indications for TKA are generally agreed to be end-stage knee OA and persistent severe pain [7 - 11] Although there is a rapid and substantial improvement in knee pain, function and HRQoL after TKA, little is known about the frequency and history of falls as well as the factors affecting falling status in patients following TKA a year after surgery in comparison to pre-operative status.

Furthermore, few studies have included pre-operative and postoperative assessments of falls, and even fewer studies have identified the type and circumstances of falls, location and related impairments and disabilities in this population and simultaneously show the possible improvement in falls frequency a year after TKA in individuals with severe knee OA, along with the estimation of self administered questionnaires and physical performance tests, examining HRQoL and other parameters of patients life.

Therefore, the purpose of this study was to investigate and determine: a) the history and frequency of falls, including mechanism or causes of falls, injuries sustained from falls reported, activity during falling and location of falls, b) the factors affecting falls, a year after TKA in elderly patients with severe knee OA.

PATIENTS AND METHODS

Patients

Overall, 68 patients (11 males and 57 females) aged 65 and older (73.00 ± 5.28 years) were recruited in the Orthopaedic Department of General Hospital in Athens "Sismanoglio-Amalia Fleming", with severe knee OA grade 3 and 4 [12] and knee pain for at least a year or more who were scheduled to receive TKA in the clinic. All patients agreed to participate in this study and signed written informed consent forms. The study was approved by the medical council of the hospital and the Ethics Committee and lasted 2 years. Some parts of the methodology and clinical characteristics of patients in this article were used in the methodology described in the article of the same authors concerning patients with severe knee OA (Tsonga *et al*., 2015) [13].

Excluded patients were those suffering from cognitive impairment (1 patient), Parkinson disease (3 patients), patients with rheumatoid arthritis (RA) (9 patients) and knee OA either not being at grade 3 and 4 classification, or not having knee pain for at least a year (11 patients). Two weeks before surgery patients completed self-administered questionnaires, were assessed in physical performance tests and personally interviewed for falls history in the past year. Every month after surgery, patients were asked to answer in a telephone interview if they had fallen in the previous month and this continued for a one-year period. If a fall was reported, then a fall history was recorded, including the mechanism or causes of falls, the activity during fall, the injuries sustained from falls and the location of falls. A year after TKA, patients completed self-administered questionnaires and were assessed in physical performance tests.

Fall assessment: 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 such as hit by a vehicle [14]. Furthermore in this research falls were focused on neuromuscular problems and also falls due to vision problems were excluded. Patients were characterized as non-fallers if they haven't reported any fall, as 1-time fallers if they have reported one fall and as frequent fallers if they have reported two or more falls.

Self Administered Questionnaires

In order to identify the factors that affected the falling status of patients we used demographic parameters and medical history such as age, gender, BMI, chronic diseases, presence or absence of social environment, the presence of pain elsewhere in the body, the presence of other arthroplasty, the history of falls and the presence of complications after the arthroplasty. Apart from these, we used self administered questionnaires examining a wide range of patients' physical function, mental function, physical activity, pain, fear of falls and, also, physical performance tests, examining patient static and dynamic stability, which are all considered as risk factors for falls according to the literature.

SF-36: One of the most widely used HRQoL tool worldwide, that evaluates general health and well-being of the elderly, combining physical, mental and social affections of the illness. It is subjective according to each individual's

personal perspectives of health [15]. It includes 36 questions in total that estimate 8 units, with higher scores (range, 0-100) reflecting better perceived health [15].

Womac: The WOMAC is a 24-item questionnaire with 3 subscales measuring: pain (5-items), stiffness (2-items) and physical function (17-items) [16]. A lower score indicates a better outcome. It has also been used to evaluate many knee OA interventions, both surgical and conservative [17].

Activities-specific Balance Confidence (ABC) Scale: The ABC is a measure of balance confidence. This instrument focuses on whether people believe they are able to perform ADLs without losing balance or becoming unsteady [18]. It is a 16-item questionnaire with a visual analog scale (0-100). A result more than 80% indicates a high level of physical function [19].

Fear of Falls (FOF): FOF was assessed as a dichotomous response to the single question: "Have you been worried or afraid that you might fall?" in order to determine the fear of falling status.

PASE Questionnaire: Physical activity was measured using "PASE" questionnaire [20]. The PASE questionnaire includes questions referring to physical activity of the last 7 days and consists of three units. The first unit includes questions for the frequency of some activities in the patient's spare time, the second unit includes questions referring to inner house activity and the third one includes questions about the duration and the type of the patient's job in the last week.

Physical Performance Tests

Timed Up and Go test(TUG) : TUG test measures the time it takes a patient to rise from an armed chair, walk 3 m, turn and return to sitting in the same chair. The TUG test is a simple test used to assess a person's mobility and requires both static and dynamic stability [21].

Berg Balance Scale (BBS): BBS is a clinical test evaluating a person's static and dynamic abilities. It is widely used to measure balance impairment in older adults through a performance-based test [22]. The scale consists of 14 common movement tasks that are scored on a scale of 0 to 4. The maximum total score on the test is 56. The items include simple mobility tasks and more difficult tasks [22].

Statistical Analysis

Data are expressed as mean±standard deviation (S.D.) 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.

McNemars test was used for the analysis of preoperative *vs.* postoperative falling status.

Unifactorial analyses was applied by using 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.

All potential risk factors, whether or not they demonstrated significant associations with outcome variable in unifactorial analysis were included in the multiple logistic regression model, and stepwise elimination (Wald method) was used to arrive at the final model. Goodness of fit was evaluated using the Hosmer-Lemeshow statistic. Any variable whose univariate test p-value < 0.25 were considered as a candidate for inclusion in the multiple logistic regression model. All tests were two-sided, statistical significance was set at $p < 0.05$. All analyses were carried out using the statistical package SPSS vr 17.00 (Statistical Package for the Social Sciences, SPSS Inc., Chicago, Ill., USA).

RESULTS

The demographic and clinical characteristics of the participants at the baseline are described in Table **1**.

Table 1. Baseline demographic and clinical characteristics of participants in this study (n=68 No, %).

Demographics and Medical parameters	
Age (years)	73.00 ± 5.28

(Table 1) contd.....

Demographics and Medical parameters	
Gender, No. (%) Male Female	 11 (16.2%) 57 (83.8%)
Social environment, No. (%) Yes No	 58 (85.3%) 10(14.7%)
BMI	30.36 ± 4.49
Chronic Diseases, No. (%) 0 1 2 3	 4 (5.9%) 24 (35.3%) 32 (47.1%) 8 (11.8%)
Complications, No. (%) Yes No	 15 (22.1%) 53 (77.9%)
Pain elsewhere in the body, No. (%) Yes No	 22 (32.4%) 46 (67.6%)
Other arthroplasty, No. (%) Yes No	 12 (17.6%) 56 (82.32%)

According to the results, there was a significant improvement in falling status of patients a year after total knee arthroplasty. In total, a year after surgery, 15 patients reported 20 falls, which defines the percentage of patients who had a fall a year after surgery at 22.1% ($p<0.001$), (Table **2**). On the contrary, in the pre-operative measurement the proportion was 63.2% [13].

Table 2. Detailed differences in falling status at 1-time fallers, frequent fallers and non-fallers patients (1 year postoperatively *vs.* preoperatively).

			Falling Status 1 year postoperatively			
			No faller	**1- time faller**	**Frequent faller**	**Total**
Falling Status preoperatively	No faller	Count	23	1	1	25
		% of Total	33.8%	1.5%	1.5%	36.8%
	1- time faller	Count	16	2	2	20
		% of Total	23.5%	2.9%	2.9	29.4%
	Frequent faller	Count	14	7	2	23
		% of Total	20.6%	10.3%	2.9%	33.8%
Total		Count	53	10	5	68
		% of Total	77.9%	14.7%	7.4%	100.0%

In general, there was 54.5% improvement of patients' falling status. According to the results, 23.5% of patients who were 1-time fallers preoperatively became non-fallers postoperatively, 20.6% were frequent fallers preoperatively became non-fallers postoperatively and 10.3% who were frequent fallers preoperatively became 1-time fallers postoperatively (Table **2**).

The frequency of 1-time fallers postoperatively was 14.7% compared to 29.4% preoperatively. The majority of 1-time fallers became non-fallers postoperatively. Specifically from 29.4% of 1-time fallers preoperatively, only 2.9% remained 1-time fallers postoperatively, 2.9% became frequent fallers and 23.5% became non-fallers. Those who became 1-time fallers postoperatively were 10.3% of frequent fallers preoperatively and 1.5% of non-fallers preoperatively. The frequency of frequent fallers was 7.4% postoperatively compared to 33.8% post-operatively. The majority of frequent fallers became non-fallers postoperatively. Specifically from 33.8% of frequent fallers preoperatively, only 2.9% remained frequent fallers postoperatively, 20.6% became non-fallers postoperatively and 10.3% became 1-time fallers postoperatively. Those who became frequent fallers postoperatively were 1.5% of non fallers preoperatively and 2.9% of 1-time fallers preoperatively (Table **2**).

According to the results of self administered questionnaires and physical performance tests, there was a significant

improvement in the one-year postoperative measurement compared to preoperative (Table **3**).

Table 3. Results of self administered questionnaires and physical performance tests preoperatively *vs*. 1 year postoperatively

	Preoperatively	1 year postoperatively	p-value
$Sf\text{-}36_{PCS}$	34.50±6.99	54.10±7.85	p<0.001
$Sf\text{-}36_{MCS}$	36.36±9.83	45.88±9.08	p<0.001
WOMAC Pain	226.10±85.24	12.87±25.00	p<0.001
WOMAC Stiffness	56.62±43.54	15.44±14.35	p<0.001
WOMAC Physical function	540.07±255.18	152.21±146.59	p<0.001
PASE	38.98±27.75	77.55±38.70	p<0.001
ABC	63.76±20.14	81.49±16.24	p<0.001
TUG	13.05±4.13	8.93±3.74	p<0.001
BBS	44.29±5.80	52.90±4.80	p<0.001
FOF (No /Yes)	12 (17,6%) /56 (82.4%)	38 (55.9%) /30 (44.1%)	p<0.001

Concerning the characteristics of falls, an alteration was detected in all parameters, but statistically significant differences in the frequencies reported, referred to minor injury (p=0.002), frequency of stumbles (p=0.003), and the falls due to muscle weakness (p<0.001) (Table **4**).

Table 4. Characteristics of falls and differences in falls characteristics (1 year postoperatively *vs.* preoperatively).

	Faller preoperatively (N=43, Falls number=65)	Faller 1 year postoperatively (N=15, Falls number=20)	p-value
Fracture	4 (6.15%)	1 (5.00%)	0.759
Minor injury	15 (23.08%)	0 (0.00%)	**0.002**
No injury	46 (70.77%)	19 (95.00%)	0.387
Stumble-triple	27 (41.54%)	18 (90.00%)	**0.003**
Slip	14 (21.54%)	2 (10.00%)	0.120
Lost balance	3 (4.61%)	0 (0.00%)	0.430
Miss step	1 (1.54%)	0 (0.00%)	0.559
Muscle weakness	20 (30.77%)	0 (0.00%)	**<0.001**
Ambulating	58 (89.23%)	19 (95.00%)	0.637
Stairs	5 (7.69%)	1 (5.00%)	0.595
Reach s/thing	1 (1.54%)	0 (0.00%)	0.559
Getting up or down from bed or chair	1 (1.54%)	0 (0.00%)	0.559
Indoors	16 (24.62%)	7 (35.00%)	0.555
Outdoors	49 (75.38%)	13 (65.00%)	0.123

The history of falls and the presence of fear of falling statistically affected falling status (Table **5**), whereas older age (Table **6**), marginally affected falling status a year after TKA.

According to the multiple logistic regression, the history of falls increased 7.2 times the likelihood of falls, the presence of FOF increased 11.9 times the likelihood of falls and the annual increase of age over 65 years increased 1.13 times the likelihood of falls (Table **7**).

DISCUSSION

A limited number of studies exists in the literature, describing the improvement in fall history and frequency a year after TKA, especially when comparing with the preoperative status in individuals with knee OA. A year after TKA the frequency of falls was 22%, significantly reduced compared to the frequency of 63.2% preoperatively. Pain relief, active movement and improved physical activity, which starts 3 months after the procedure and reaches its optimum level a year later, minimized that risk and reduced the post operative falls rate to 22.1% as recorded in our study, a figure that was lower to the one reported even for healthy community living older adult population [23 - 25]. The findings of this study do not permit us to determine the parameter, whose positive change precedes that of the others assessed in this study and succeeds in reversing the negative chain of pain, muscle weakness, instability, stiffness, disability and poor quality of life. It was though clear, that this chain was reversed a year after TKA, possibly finding the relief of pain on the top of the scale.

Table 5. Unifactorial qualitative analysis of falling status 1 year postoperatively.

		1 year postoperatively		
		Falling status		p-value
		No	Yes	
Gender	Male	10 (18.9 %)	1 (6.7 %)	0.433
	Female	43 (81.1 %)	14 (93.3 %)	
History of falls	No	23 (92.0 %)	2 (8.0 %)	**<0.0005**
	Yes	30 (69.8 %)	13 (30.2 %)	
FOF	No	34 (64,2 %)	4 (26,7 %)	**0.017**
	Yes	19 (35, 8 %)	11 (73,3 %)	
Pain elsewhere in the body	No	38 (71.7 %)	8 (53.3 %)	0.218
	Yes	15 (28.3 %)	7 (46.7 %)	
Chronic diseases	1	22 (41.5 %)	6 (40.0 %)	1.000
	2 or 3	31 (58.5 %)	9 (60.0 %)	
Complications	No	43 (81.1 %)	10 (66.7 %)	0.303
	Yes	10 (18.9 %)	5 (33.3 %)	
Social environment	No	7 (13,2 %)	2 (13.3 %)	1.000
	Yes	46 (86.8 %)	13 (86.7 %)	
Other arthroplasty	No	42 (80.8 %)	13 (86.7 %)	0.721
	Yes	10 (19.2 %)	2 (13.3 %)	

Apart from a significant reduction in the frequency of falls, an improvement of 54% in the falling status of patients was observed. The greater improvement was observed on the behavior of frequent fallers, since they improved their falling status from 33.8% to 7.4%. This group was more vulnerable since they fell more often and with the background of weakness and instability that characterizes them, they were in greater risk of injury. That change supported the belief, that the patients in our study regained their normal physical activity and balance and stopped being so unstable, like they were before due to severe knee OA. Nevertheless, there was a proportion of patients (19%), who maintained their falling status and remained fallers in both measurements, but that rate was considered to be within the normal limits of 30% of fallers among the elderly population.

Previous studies conducted with TKA patients have presented similar findings although not so positive, starting from Swinkels *et al*., (2009) [26], reporting a postoperative fall rate of 24.2%, Matsumoto *et al*., (2012) [27], reported fall rate of 32.9% and Levinger *et al*., (2012) [28], reported a fall rate at 40%. When comparing postoperative results to preoperative status, a significant difference was reported in fall rate, although Swinkels *et al*., (2009) [26], found almost the same results preoperatively and postoperatively and no significant difference. Additionally, Matsumoto *et al.*, (2012) [27], didn't have a preoperative measurement to compare and Levinger *et al*., (2012) [28], reported a reduction in fall rate from 48.5% to 40%, but that difference was not significant.

According to the literature the intrinsic risk factors that are responsible for 39% -53% of falls in the community older adult population are history of falls [23, 29, 30], advanced age [25, 31], gender [25, 31], muscle weakness, reduced physical activity [32], mobility disorders and abnormal gait [33 - 35], sedentary life [36], fear of falling [23, 37 - 39] chronic diseases [40, 41] and solitary life [42]. In the present study, the factors that affected falling status were the history of falls, fear of falls and advanced age. In addition the history of falls increased 7.2 times the likelihood of falls, whereas the presence of FOF increased 11.9 times the likelihood of falls. In contrast to other studies [26, 31, 39 - 41], a year after TKA, factors like chronic diseases, solitary life, reduced physical activity and gender didn't affect falling status. Those factors seemed more likely to influence fear of falls rather than history of falls [43].

A year after TKA, the main cause of falls was tripping and stumbling and the majority of falls took place during walking. In most cases, the main cause of stumbling is minor. But the adjustment, reaction speed and muscle strength required to overcome the obstacle is beyond the ability of the elderly person to overcome [44]. Furthermore there was a notable minimization of the presence of muscle weakness as a cause of falls, indicating that most patients gradually regain satisfactory levels of muscle strength even though that was not measured directly.

Table 6. Unifactorial quantitative analysis of falling status 1 year postoperatively.

	Falling Status	1 year postoperatively		
		Mean	**SD**	**p-value**
Age	No	72.43	5.42	0.097
	Yes	75.00	4.34	
BMI	No	30.46	4.50	0.720
	Yes	29.99	4.44	
Sf-36PCS	No	54.08	8.28	0.972
	Yes	54.17	6.39	
Sf-36MCS	No	46.41	8.63	0.369
	Yes	44.00	10.63	
WOMAC Pain	No	12.74	27.13	0.936
	Yes	13.33	16.00	
WOMAC Stiffness	No	16.04	14.79	0.523
	Yes	13.33	12.91	
WOMAC Physical function	No	141.04	152.47	0.240
	Yes	191.67	119.77	
PASE	No	77.64	39.85	0.971
	Yes	77.22	35.63	
TUG	No	8.94	3.66	0.758
	Yes	9.27	3.55	
ABC	No	82.05	16.90	0.595
	Yes	79.50	13.99	
BBS	No	52.87	5.02	0.926
	Yes	53.00	4.07	

The risk of fracture after TKA was also a matter of investigation. A year after TKA, when pain and stiffness was decreased and function was improved, we would expect that the risk of fracture would diminish as well. Nevertheless the reduction was not significant compared to the pre-operative evaluation. However, the result would be considered satisfactory, considering that studies with community older adult population report that approximately 1 in 10 falls result in a serious injury, of which 5% are fractures [14, 23, 29]. In our study that rate was 1 in 20 falls. On the other hand, there was a significant improvement in the frequency of minor injuries, which leads to the conclusion that the risk of serious injury decreased significantly after surgery compared to the preoperative evaluation.

Table 7. Multiple logistic regression of falling status 1 year postoperatively (stepwise method).

		Reference category	**O.R**	**95% CI**		**p-value**
Stepwise Method	Age	---	1.13	0.98	1.30	**0.084**
	FOF	No	11.90	2.20	64.20	**0.004**
	Falling status	No	7.23	1.28	41.01	**0.025**

The difference between indoor and outdoor falls was also a matter of interest. Although most elderly people spent their time primarily in their home [45] the studies indicate that at least 50% of falls take place outdoors [46 - 49]. Similarly in our study the frequency of outdoor falls was 65%.

Acknowledging the limitations of the study, we would identify the small number of patients because the research included only patients with severe knee OA a year after TKA. Nevertheless, there are numerous studies examining falls for community living elderly population but there are only few examining patients a year after TKA.

CONCLUSION

Based on the results of falls frequencies, falls characteristics and differentiation of falling status, we can conclude and support the belief that a year after TKA, patients with severe knee OA significantly reduced the frequency of falls and the consequent risk they provoke.

TKA generally improved a lot of aspects in patients' life. One of these was the reduction of fall risk, which always co-exists in this population, causing devastating problems threatening the benefits of the procedure.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

Declared none.

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