

Original Article

The benefits to functional ambulation and physical activity of group-based rehabilitation in frail elderly Bulgarians undergoing total knee arthroplasty. Preliminary results

Julian Krumov¹, Vasil Obretenov¹, Alexandrina Vodenicharova², Kostantin Kanalev³, Vladimir Stavrev⁴, Troycho Troev⁵, Jannis Papathanasiou⁶

¹Clinic of Orthopedics and Traumatology, Military Medical Academy Varna, Bulgaria; ²Department of Health Policy and Management Faculty of Public Health, Medical University of Sofia, Bulgaria; ³Department of Physical Education and Sport, Faculty of Medicine, Medical University of Plovdiv, Bulgaria; ⁴Department of Orthopedics and Traumatology, Medical University of Plovdiv, Bulgaria; ⁵Department of Physical Medicine and Rehabilitation, Military Medical Academy, Sofia, Bulgaria; ⁶Department of Kinesiotherapy, Faculty of Public Health, Medical University of Sofia, Bulgaria, Department of Imaging, Allergology & Physiotherapy, Medical University of Plovdiv, Bulgaria

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Abstract

Objectives: Frailty is a geriatric syndrome associated with increased vulnerability of older adults. Knee osteoarthritis (OA) is the most prevalent joint disease and one of the leading causes of disability and poor physical activity (PA) of elderly individuals worldwide. Total knee arthroplasty TKA has been recognized as an effective surgical treatment in end-stage of knee OA. There is a lack of consensus regarding the universally accepted rehabilitation protocol for frail elderly subjects after TKA. **Aim:** to evaluate the potential benefits in functional ambulation (FA) and PA among frail elderly Bulgarian subjects underwent TKA, a novel group-based rehabilitation protocol was performed from the subjects. **Materials and methods:** A total of 130 frail elderly Bulgarian TKA recipients (67 women and 63 men aged 72, 69 ± 0.44,) were included. FA was assessed by the six-minute walking distance (6MWD). PA was evaluated by the PASE questionnaire. Participants were evaluated one week before TKA, as well as 3 and 6 months after the group-based rehabilitation. **Results:** Significant increase in FA was observed at the third and sixth month after the group-based intervention ($p < 0.001$). PASE score, was increased at the third and sixth month after the group-based intervention ($p < 0.001$, $r^2 = 0.74$). **Conclusions:** Our results suggest that the applied group-based intervention led to a significant improvement in FA as well as in PA of frail elderly subjects over the first six months after the group-based intervention.

Keywords: Knee Osteoarthritis, Group-based Rehabilitation, Frailty, PASE, Total Knee Arthroplasty

Background

Ageing may be conceptualized as a process of progressively increased entropy coupled with reduction and subsequently failure of the homeostatic mechanisms¹. Aging process may cause several modifications in muscle strength, postural control, balance, and gait, which are considered the main components of frailty². A decline in physical function and significant increases in the risk for disability and dependence are typical of elderly adults. Frailty is a geriatric syndrome associated with increased vulnerability of older adults to stressors and decreased ability to regain physiological functions after a destabilizing event^{3,4}. It is highly prevalent in people older than 65 years

(7-16.3%) and can increase, up to 25% in people over 85 years^{5,6}. There is general consensus that frailty results from underlying physiologic and/or biologic alterations that

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Corresponding author: Dr. Julian Krumov, MD, Clinic of Orthopedics and Traumatology, Military Medical Academy Varna, Bulgaria

E-mail: ortomed.dr.krumov@abv.bg

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are age-associated and maybe compounded by single or multiple diseases, or even be an end-stage outcome of several disease¹.

OA is the most prevalent joint disease and one of the leading causes of disability and poor PA among elderly individuals⁷. It is estimated that nearly 40% of individuals above 65 years are affected from some type of symptomatic OA and approximately 700.000 persons, annually-elect to undergo total knee arthroplasty TKA⁸. TKA has been recognized as an effective surgical treatment and over the next 2 decades, the number of TKAs is expected to reach 3.48 million⁹.

Physical activity (PA) is defined as any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level¹¹. Scientific literature showed that regular PA reduces the risk of developing cardiovascular and metabolic diseases, obesity, cognitive decay, osteoporosis, and muscular atrophy as well as the risk of falls in both healthy and frail elderly individuals¹². Despite the above mentioned health benefits, regular PA may be a risk factor for developing OA due to mechanically induced degeneration of cartilage and bone^{13,14}.

Older adults tend to slow their walking speed and to show a slower reaction to external stimuli¹⁵⁻¹⁸. Walking capacity in elderly subjects underwent TKA is limited because of residual knee pain and reduced muscle strength. It has been shown that early mobilization in elderly TKA population, achieved within 24 h, reduce the risk of postoperative complications such as venous thromboembolism, pneumonia, atelectasis, urinary tract infections, sepsis, myocardial infarction and stroke, as well as the length of hospital stay^{19,20}.

Six-minute walk test (6MWT) referred as effective tool for assessing mobility in frail subjects²¹ as well as a predictor of functional ambulation after TKA²². It's proven that 6MWT is highly correlated to 30MWT and two-minute walk tests. The 30MWT test did not demonstrate greater capacity to differentiate between individuals, as well as not have stronger correlations with patient-reported outcomes compared to the 6MWT.

Currently, there is a lack of consensus regarding the universally accepted rehabilitation protocol for frail elderly subjects after TKA. One-to-one therapy is widely used in Australia, while the group-based interventions are commonly applied in the United Kingdom and Scandinavian countries^{23,24}. Previous RCTs have shown that one-to one rehabilitation is not superior to group-based, home-based, as well as tele-rehabilitation programs, after TKA²⁵⁻²⁷. The present study prospectively evaluates the potential benefits on FA and PA in a cohort of frail elderly Bulgarians underwent TKA, performed a group-based rehabilitation.

Materials and methods

The TKA cohort consisted of patients from Clinic of Orthopedics and Traumatology of Military Medical Hospital-Varna from April 2013 to March 2017. The duration of

Age (years)	72.69 ± 0.44,
Gender	67 women and 63 men
Weight (Kg)	81.96±15
Height (cm)	167, 5±3.2
BMI (Kg/m²)	29.39±5.27
Civil status	52% Married, 31% Widowed, 17% Divorced
Educational level	76, 1% University & Coll, 16,9 % High School, 6.9% - Primary
Systematic disease	38% none, 62% with SD
TKA on the contralateral limb	7,7% yes

Table 1. Baseline demographic and clinical characteristics of the elderly frail subjects.

the follow-up was 6 months. One hundred and thirty frail subjects (aged: 73, 32 ± 0.40 years, 67 women and 63 men) were consecutively recruited from Clinic of Orthopedics and Traumatology of Military Medical Hospital - Varna from April 2013 to March 2017. Eighty-three of them (63, 8%) were older aged, while forty-four were oldest (36, 8%). Elderly frail subjects were eligible to participate if they scheduled to undergo primary or simultaneous bilateral TKA secondary to knee OA and aged 60 to 85 years. Excluded were elderly subjects after revision, post-surgical infection, neuromuscular impairments, cardiovascular impairments, uncontrolled hypertension, uncontrolled diabetes, progressive cancer were excluded. The elderly participants were assessed one week before TKA as well as three and six months after the applied group-based intervention. Health professionals from Rehabilitation Center Pobeda, Varna-Bulgaria, administered the PASE questionnaire in face-to-face interviews and supervised the 6MWT. All patients received written information about the procedures of the study, and informed consent was obtained in accordance with the Declaration of Helsinki. The baseline anthropometric, demographic and clinical measurements of the frail elderly subjects are presented in the Table 1.

Physical Activity; PASE Questionnaire

The measurement of the PA level in elderly subjects requires valid and reliable instruments that are enough simple and at the same time flexible enough to be adjusted to the challenges of impaired mobility that is prevalent in older adults. One of the more traditional methods is the PASE questionnaire, which is a brief and easily scored tool developed to assess PA²⁸. In order to be more reliable the PASE questionnaire can be administered by mail or interview²⁹. The questionnaire evaluates the PA of the past 7 days in three life domains: recreational, household and work-related activities. The first domain includes questions

Age Group	PASE1	PASE2	PASE3	Δ(%)	6MWD1	6MWD2	6MWD3	Δ%
Older	41,77±2,79	54,05±2,94	64,81±3,60	55,56	338,93±9,96	384,03±12,30	407,91±10,59	20,40
Oldest	39,60±2,32	51,81±3,22	61,13±3,76	54,64	334,70±9,55	378,00±13,56	398,06±10,90	18,97

Table 2. Physical activity and six-minute walking distance of the both age-related groups.

concerning weekly frequency of recreational activities (e.g. walking, light sports), sports with great intense (dancing) and exercise for the increase of the muscular system (e.g. weights). The second domain includes questions referring to household activities (inner house activities). The third domain includes questions referring to the duration and the type of the patient's job for the last week. The total score was measured by adding all the subscores. Additionally, the validity and reliability of the PASE questionnaire in the English population is referred at 0.65 and 0.75 respectively, while the reliability in the Bulgarian population is high.

Six-minute walk test

In many studies has been shown that functional capacity as well as the walking speed declines with age and that men outperform women at all ages³⁰. 6MWT is a simple and objective tool used to assess the functional capacity and its impairments due to chronic cardiorespiratory and/or musculoskeletal conditions, particularly in frail elderly subjects³¹.

The use of the 6MWT in frail subjects content validity as improvement in mobility is regarded as the primary goal of post-TKA rehabilitation³². The 6MWT was applied due to its easy implementation, high responsiveness and better acceptance by the patients, compared with other field tests²². Elderly subjects performed the 6MWT according to the guidelines published by the American Thoracic Society³³. They were instructed to walk as fast as possible during the 6 minutes, on 35-meter outdoor footpath of Rehabilitation Center Pobeda, Varna- Bulgaria. During the test, the administrator walked behind the participants in order to note any clinical manifestations (pain, dyspnea, angina, faintness, balance disorders, etc.) that might influence the test's quality. The elderly subjects performed the 6MWT one week before TKA, as well at 3 and 6 months after the group-based intervention. It has been proven that 6MWT is a moderate indicator of submaximal and maximal exercise capacity of elderly subjects with knee OA³⁴.

Group-based rehabilitation intervention

The included elderly subjects (n=130) performed a supervised group-based protocol, especially designed for elderly TKA recipients. The group-based intervention commenced two weeks after the TKA, and conducted for a first time in Bulgaria, in Rehabilitation Center Pobeda, in the

city of Varna. The protocol encompasses warm-up, general aerobic, and cool down activities. Elderly subjects performed unilateral and bilateral weight-bearing exercises, stairs climbing and balance retraining, as well as gait training, progressive and strengthening exercises (PSE). PSE targeted the quadriceps, hip abductors, adductors, extensors and flexors, ankle plantar flexors, and hamstrings. The intensity training was adjusted by specially selected musical pieces. The overall duration of the group-based intervention was 12 weeks. In order to obtain faster clinical outcomes, participants were allocated into 17 training groups. The physiotherapist-to-patient ratio did not exceed 1:8 in each subgroup. The goals of the group-based protocol were to decrease pain, to reduce the functional impairments, as well as to maximize the ADLs and quality of life of the elderly subjects primary underwent TKA. No adverse effects during the training sessions were observed.

Statistical analysis

Data are expressed as mean \pm 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 Chi square test was used to compare differences in age, gender and BMI among elderly TKA population. A mixed-model ANOVA repeated measures was used on outcome measures (6MWT, and PASE, scores) with time (levels: T1, T2, T3) as within-subjects factor and type of rehabilitation intervention (group-based intervention) as between-subjects factor while controlling for clinical characteristics (comorbidity, TKA on the contralateral limb etc.). Statistical significance level was set at $p < 0.05$ for both main and interaction effects. For all analyses, $P < 0.05$ was deemed as significant. All analyses were carried out using the statistical package SPSS v19.00 (Statistical Package for the Social Sciences, SPSS Inc., Chicago, Ill., USA).

Results

The percent of older frail subjects included in our study was significantly higher than oldest TKA recipients ($\chi^2=83,00$, 00 ; $p=0.002$). No statistically significant gender differences and comorbidities were observed in both age-related groups. More than 85% of participants were overweighted ($\chi^2=25,40$; $p < 0.01$). Approximately 74% of

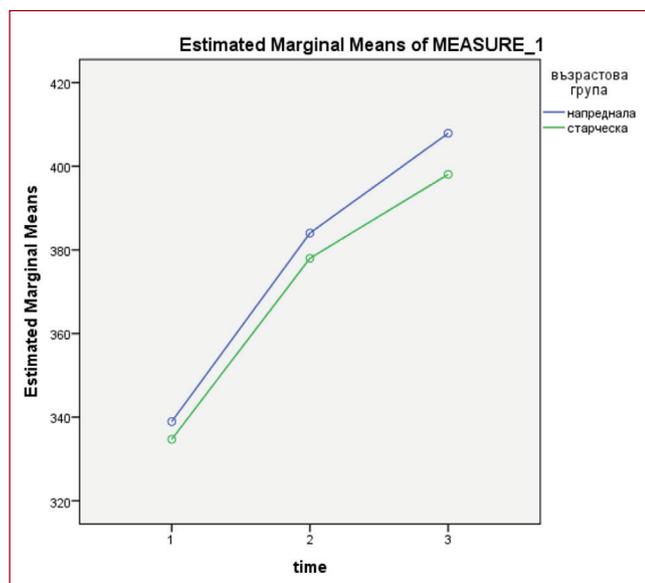


Figure 1. The increase of 6MWD in both age-related groups.

older subjects were highly-educated, whereas only 7, 37% of the oldest participants were primary educated ($p < 0.001$ (Table 1).

Preoperative PASE score of older participants was 41,77 whereas the same score achieved in oldest subjects of our study was 39,60. PASE scores were improved significantly in both age-related groups at any follow-up ($p < 0.05$). Six months after the group-based intervention the PASE scores were significantly increased in both age-related groups respectively 64,81 for older group and 63,39 for the oldest (Table 2). The improvement in PA observed in older women was greater compared to the same improvement observed in older men, but the difference between genders was not statistically significant ($p < 0.05$).

According to the results of the ANOVA analysis with repeated measures there has been a significant influence of the factor "time" $F(2,243)=5545, 42, p < 0.001$. Significant improvement was observed in both age-related group, without relationship to any age group $F(1,128)=0, 06, p > 0,05$, as well as the interaction of the two factors $F(2,243)=1, 05; p > 0.05$.

Both age-related groups increased the 6MWD at any follow up, while in the elderly healthy weight individuals of our study the increase was greater. No participants stopped to rest during the 6MWT. Six months after the group-based rehabilitation the older subjects increased the 6MWD by 68 m., 20.40%, respectively while the increase observed by the oldest participants was nearly 66 m., respectively 18.97%. The increase of 6MWD in both age related groups as well the difference between groups are presented in the Figure 1.

No significant influence of the factor "BMI category"

has been observed $F(2,127)=2, 24, p > 0.05$, whereas the factor time $F(2,254)=2742, 75, p < 0.001$ was significant factor generally, as well as the interaction between factors, time and BMI category $F(4,254)=2, 81, p < 0, 05$. Moreover the Bonferonni corrected post hoc tests showed significant differences at baseline as well as 6 months after the group-based intervention among the elderly healthy weighted participants ($p < 0.05$).

Discussion

This was a prospective study, aimed to evaluate the potential benefits on FA and PA of a novel group-based intervention applied for first time in Bulgaria among elderly TKA population. Currently, there is a lack of consensus regarding the universally accepted rehabilitation protocol for frail elderly subjects after TKA. In previous studies have been shown, the superiority of group-based interventions compared to one-to one, home-based and tele-rehabilitation programs^{25-27,35}. The significant increase in PASE scores in both age-related groups at the third and sixth month, after the group-based rehabilitation is strong evidence that the applied intervention led to increase of the PA in both age-related groups performed group-based rehabilitation. The majority of oldest participants of the TKA cohort included in our study were primary educated, with poor social and financial status, and significant co-morbidities, which were potentially related to the lower baseline scores in PASE and FA compared to the older TKA group. Older and oldest men achieved higher PASE scores than the older and oldest women, mainly because of higher work-related activity scores. Tsonga et al., reported higher PASE scores in a study included fifty two elderly women with knee OA underwent primary TKA³⁶. The lower PASE scores achieved from the participants of our study may be attributed on the one hand to the higher percentage of oldest participants, as well as a higher percentage of obesity, and the number of systematic diseases to another. Despite the improvement observed between pre-and postoperative measures in the obese elderly subjects of our study, they reported more pain and functional limitations. Our study deepens our knowledge in FA of elderly TKA subjects and contributes to the existing literature on FA of elderly subject after TKA. In the of study Ko et al., was provided long overdue construct validity for the use of 6MWT as a measure of FA in TKA recipients²². 6MWD was significantly increased in both age-related groups of our study, six months after the group-based intervention.

The distance covered by the older subjects during 6MWT was increased by 20.40%, while the increase achieved by the oldest participants was 18.97% (Table 2). In our study, we have data which provide comparisons between age-related groups among TKA recipients in terms of 6MWD.

Frail elderly subjects are characterized by an impaired ability to cope with challenges in health and reduced ability to regain a stable health status, possibly related to reduced functional reserve in our study presented as reduced FA³⁷.

There were several limitations to our study. The results achieved by both age-related groups are limited to six-months after the group-based intervention. The significantly lower number of oldest TKA participants included in our study influenced the poor baseline scores in PASE and FA in this group. Potential limitations were also some of the exclusion criteria, as well as the difficult access of the elderly subjects to the Outpatient Rehabilitation Center Pobeda, in Varna.

Conclusions

The benefits to FA and PA of the group-based intervention in elderly Bulgarian TKA subjects were highlighted in our study. The significant increase in 6MWD and PASE scores observed in all subjects, at the third and sixth month after the applied intervention, are strong evidence that the group-based rehabilitation provide long term benefits in FA and PA among elderly subjects. Finally, was confirmed that the 6MWT test is an excellent predictor of longer duration ambulation after TKA.

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