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Physical Activity Level and Physical Function in Patients with Total Knee Replacement Three Months after Surgery- A Cross-Sectional Study

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Abstract

Purpose: The aims of this study to investigate the level of physical activity and physical function three months post-surgery in patients > 55 years old who had received knee arthroplasty. A second aim was to examine the relationship between objectively measured physical activity level and physical function.

Methods: A consecutive sample of 43 participants, 28 (65%) men, 15 (35%) women with a mean age of 70.7 years three months after total knee arthroplasty were included. Outcome measures were levels of physical activity (steps and total energy expenditure) registered with accelerometer worn for seven days. Physical function was measured with the Short Physical Performance Battery.

Results: Participants walked on average 6068 steps per day, and the mean total energy expenditure was 2494 kcal per day three months after surgery. Walking speed was low. The correlation values between the number of steps per day and walking speed indicated that those more physical active had better physical function.

Conclusion: Three months after knee replacement surgery, participants, had not reached the recommended level of physical activity. Thus, interventions aiming to increase physical activity early in rehabilitation should be emphasized.

Keywords: Knee arthroplasty; Physical activity; Physical function; Rehabilitation; Walking speed

Introduction

Maintaining a high level of physical activity is vital, as it has been shown that a low physical activity level contributes to loss of physical function, can lead to an increased risk of developing chronic diseases and increased mortality in the elderly [1]. Physical activity is defined as "all work produced by skeletal muscles that requires energy expenditure", including activities performed during work, play, housework, traveling and outdoor activities [2]. At least 10,000 steps per day is recommended for healthy individuals < 65 years old to achieve a health-promoting effect [3]. Individuals > 55 years old are recommended to take at least 8000 steps per day [4].

Studies have shown that a sufficient level of physical activity, according to guidelines [3,4] is not always achieved after knee surgery [5], probably due to patients' fear and uncertainty about their own ability [6,7]. A systematic review by Arnold et al. [8] showed that patients undergoing knee replacement increased their physical activity level only marginally in the first six months after surgery and that their activity level one year postoperatively was significantly lower than that in healthy control groups. In addition, Naal and Impellizzeri [9] conducted a systematic review that comprised follow-up points between one month and 10 years and found that people walked an average of 6700 steps per day after a hip or knee replacement, i.e., fewer steps than recommended. In contrast, Hepperger et al. [10] showed that six months after surgery, 43% of the patients had resumed the same activity level that they had before surgery, and 35% of the patients had even higher activity levels. Sex-related differences were observed and indicated higher activity levels in male than in female patients at 6, 12 and 24 months postoperatively [10]. Few studies have

investigated the level of physical activity and physical function in patients with total knee replacement three months after surgery. A time when those patients are supposed to be back to pre-surgery level. In addition, a better understanding of the relationship between physical function and physical activity at this time point could minimize the negative effects of low physical activity levels as physical function is a prerequisite for physical activity.

In Sweden, 12,428 primary knee replacements were performed in 2014. Of these, 95.6% were total knee replacements and 56-60% was performed in women [11]. The incidence is highest in people aged 65-84 years. Primary arthroplasty is defined as the first replacement surgery in the knee in question [11]. The main reason for knee replacement surgery is osteoarthritis (OA), and the primary aim of surgery is to reduce pain and increase mobility and physical activity levels [12]. Hip and knee OA is ranked as the 11th highest contribution to global disability [13], with sufferers commonly reporting pain, activity limitations, and a diminished health-related quality of life [14]. Sex has been shown to affect both function and pain relief after total knee replacement [15]. Although women achieve at least the same degree of functional improvement as men, women have worse preoperative physical function and do not reach the same final level of physical function as men [15].

Total knee replacement typically leads to large improvements in pain and self-reported function [12]. However, improvement in objectively measured physical function and activity levels post-arthroplasty has yet to be convincingly demonstrated as a self-reported increase may be due to an perceived improvement in pain [4]. The level of physical- function and activity, measured objectively, in patients with total knee replacement three months after surgery issparingly investigated. This should be done to optimize the rehabilitation after total knee arthroplasty, as a common goal following total knee arthroplasty is to become more physically active [16]. It is important that health professionals include strategies to improve the level of physical activity and physical functioning to increase health [2,5]. Identifying the relationship between physical activity and other factors at an early stage of the rehabilitation process may facilitate the selection of successful strategies [4]. It is therefore important to examine levels of physical activity, physical functioning, and the relationships between physical activity and physical functioning (such as gait velocity) in the early phase of rehabilitation. This knowledge may ensure that each patient receives optimal rehabilitation that is tailored to stimulate activity on an individual level. The aims of this study to investigate the level of physical activity and physical function three months post-surgery in patients > 55 years old who had received knee arthroplasty. A second aim was to examine the relationship between objectively measured physical activity level and physical function.

Methods

Study Design: The study was a one-group cross-sectional study with a descriptive and correlative design.

Participants: The first author asked consecutive subjects to participate between January and August 2016 at an orthopedic inpatient department in Stockholm, Sweden, after the patients had completed primary knee replacement surgery. An information letter describing the study was given to eligible patients, if possible, the day after surgery. Patients were also verbally informed of the voluntary nature of participation in the study, their right to terminate participation at any time without reason, and of the guaranteed confidentiality. A convenience sample of 64 patients was asked to participate. When 50 patient had accepted participation in the study the recruiting process stopped. The inclusion criteria were being over 55 years old and receiving primary total knee arthroplasty. The exclusion criteria were not understanding Swedish or having undergone revision surgery. The Regional Ethical Review Board approved the study (Dnr 2015/275).

Of the 50 included patients, six patients cancelled their participation before the first visit, which corresponds to a loss of 12%. Reasons for cancellation were inadequate transportation to the hospital, long-term stay abroad, knee re-operation, non-attendance at the scheduled visit or inability to be contacted, cancellation without a reason, and a fall that resulted in a fracture. One additional participant was lost due to a problem with downloading data from the accelerometer to the computer, resulting in a total loss of 14% (i.e., seven participants). The seven dropouts consisted of two men and five women with a mean age of 73.9 years. The mean age of the 43 patients was 70.7 years, and 65.1% were men (Table 1). The time from surgery to assessment of physical activity and physical function was 108 days on average (table 1).

Variables	Total N = 43	Women N = 15	Men N = 28
Age, years	70.7 (7.3)	70.7 (6.9)	70.6 (7.7)
BMI, kg/m	28.4 (3.5)	28.6 (3.6)	28.2 (3.7)
Days after surgery*	108 (11.4)	110 (13.0)	106 (10.4)

*Time from surgery to assessment of physical activity and function

Table 1: Description of background variables (mean (SD)).

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Written informed consent was obtained from interested patients before hospital discharge, and each patient received an appointment at the physiotherapy clinic three months post-operation. At this visit, an accelerometer (MiniMod) [17], was applied, and the patient received information about how the measurement should proceed during the following seven days and nights. At the second visit one week later, the patient returned the accelerometer, and physical function (i.e. balance, walking speed and functional leg muscle strength) was measured.

At the hospital patients started to exercise the same day or the day after surgery and performed the exercise daily under supervision of a physiotherapist. The program included foot tramps, active supported knee-flexion/-extension and active quadriceps work while lying down, active knee-extension while sitting, and supported knee-flexion while sitting. Each exercise was designed to be performed 5 to 10 times (repetitions) at each session. In addition, daily training with walking aids, usually walking table day one and then whit crutches were performed. Before discharge, all patients were instructed by a physiotherapist to continue with the exercises at home 3 to 5 times per day. Patients were also recommended to

contact a physiotherapist in their primary care network within one week to schedule an appointment for further support. If they were unable to visit a primary care clinic, they received a referral to home rehabilitation. The physiotherapy intervention varied from 2 to 3 times per week to 2 to 3 times over the course of 3 months.

Outcome Measurements

Background Data: Demographic data included: age, height and weight were collected from medical records.

Physical Activity: Physical activity was objectively measured with an accelerometer (MiniMod) [17]. The accelerometer is approximately 8.5 cm x 6 cm tall and 1.1 cm wide and was fastened around the waist with a ribbon. The MiniMod is valid for use in measuring body movement, position and energy expenditure. High validity was demonstrated in a study comparing the accelerometer records with video filming of activity patterns [18]. The accelerometer was worn for seven days and nights. The number of steps per day and total energy expenditure (TEE) in kcal were recorded. Steps per day was calculated as the mean of the recorded days. TEE was calculated by multiplying the basal metabolic rate by a value corresponding to the average physical activity level during the day [19]. Valid accelerometer wear-times was accepted as ≥ 10 hr of monitoring on ≥ 5days of the week [21]. No account was taken to whether the accelerometer was worn on weekdays or holidays.

Physical Function: Physical function was assessed with the Short Physical Performance Battery (SPPB), which is a valid and reliable test designed for older people [20,22]. Freiberger et al. [23] showed that the SPPB has high predictive validity regarding mortality, walking difficulty, general health and difficulty with activities of daily living (ADL). The test consists of three parts: 1) balance; 2) walking; and 3) leg muscle strength with scales that range from 0 to 4, in which 0 is considered not passing the test.

Balance Test: The time that the person could stand in three different positions was documented: feet together, semi-tandem and tandem standing. Four points were given if all positions were managed for at least 10 seconds.

Walking Test: Time was noted for walking four meters, and it was also noted if the participant used a walking aid. Two trials were performed, and the best value was registered. Four points were given if the walking time was < 4.82 seconds. Additionally, walking speed (m/sec) was calculated.

Functional Leg Muscle Strength Test: The time it took to stand up and sit down as quickly as possible five times without stopping with the arms folded across the chest was recorded. To obtain four points, five up/down cycles in < 11.19 seconds were required. The total score on the SPPB is 12 points, and a higher score reflects better physical function [22].

Statistical Analyses

IBM SPSS Statistics, 21 was used for statistical analysis. Background data, i.e., age, BMI, number of steps, TEE and walking speed, were reported as the mean and standard deviation.SPPB scores were reported as the median (Q1-Q3) because the data were ordinal. The differences between men and women were analyzed either with a t-test when the data were normally distributed and of an interval type or with a Wilcoxon signed rank test when the data were not normally distributed and/or were of the ordinal type.

Correlations between steps per day and different dimensions of the SPPB were analyzed with Spearman's rho. The strength of the correlation was classified as follows: < 0.40 = poor, 0.41-0.60 = moderate, 0.61-.0.80 = good, and 0.81-1.0 = very good [24]. The significance level was set at $p < 0.05$.

Results

Level of Physical Activity

Patients walked on average 6068 steps per day (Table 2). The average TEE was 2494 kcal per day, and there was a significant difference in TEE between men and women (table 2).

Variable	Total n = 43	Women n = 15	Men n = 28	p-value
Mean Steps/day	6068 (3404)	5385 (3114)	6433 (3549)	0.34
Mean TTE/day, kcal	2494 (469)	2168 (3114)	2668 (450)	< 0.001

Table 2: Number of **S**teps and TEE measured with an accelerometer.

Physical Function (SPPB)

The median physical function (assessed by SPPB) was 10 points out of 12 possible scores (Table 3). Both balance and gait had a maximum average score, whereas functional leg muscle strength averaged a score of 3 out of 4. The mean self-selected walking speed was low at 0.88 m/s.

Variable	Total n = 43	Women N = 15	Men N = 28	p
Total SPPB score, md (Q1-Q3)	10.0 (7-12)	8.0 (7-12)	11.0 (8-12)	n.s
Balance, md (Q1-Q3)	4.0 (4-4)	4.0 (2-4)	4.0 (4-4)	n.s
Gait, md (Q1-Q3)	4.0 (3-4)	3.0 (2-4)	4.0 (3-4)	n.s
Self-selected walking speed, m/sec m (SD)	0.88 (0.25)	0.81 (0.28)	0.91 (0.23)	n.s
Functional leg strength, md (Q1-Q3)	3.0 (1-4)	3.0 (1-4)	3.0 (2-4)	n.s

n.s =not significant

Table 3: Scores on the Short Physical Performance Battery (SPPB) and self-selected walking speed.

Correlation between Steps Per Day and Physical Function

The correlation between steps per day and walking speed was moderate, r = 0.57 ($p < 0.001$), and the correlation between steps per day and SPPB score was also moderate, r = 0.43 (p = 0.004). The correlation coefficients for women were low and not significant, whereas men's values were significant (Table 4).

Correlation between steps per day and:	Total n = 43 rho (p-value)	Women n = 15 rho (p-value)	Men N = 28 rho (p-value)
Walking speed	0.57 (0.000)	mean (SD).0.46 (0.08)	0.61 (0.001)
SPPB score	0.43 (0.004)	0.28 (0.31)	0.52 (0.005)

Table 4: Correlation coefficients (rho) between steps/day and physical function.

Discussion

We found that three months after surgery, our patients walked 6068 steps per day on average, which is lower than the recommended 8000 steps for subjects > 55 years old [4]. Our result is in agreement with the findings from a systematic review of physical activity levels in patients with hip and knee replacements performed by Naal and Impellizzeri [9]. They found that their patients walked an average of 6700 steps/day postoperatively, but the measurement period where spread from one month to as long as ten years postoperatively. Several factors may explain the low number of steps per day in our study. The patients may still not trust the newly operated knee and its function. This is consistent with previous studies showing that patients are afraid and uncertain about their own ability [6,7]. However, three months should be a sufficient time to achieve effects of exercise if the support is good enough [25]. In a systematic review, Smith et al. [26] showed that patients with osteoarthritis had low expectations of being able to return to sports or other physically strenuous activities postoperatively despite their desire to do so. Increased knowledge on how the knee arthroplasty tolerates physical strain may help patients feel more confident in performing physical activities. Many patients undergoing knee replacement may prefer riding a bike to walking, as they feel that cycling does not load the prosthesis as much as walking does, and thus this may be a reason for the relatively low number of steps per day.

We found the mean TEE to be 2668 kcal/day for men and 2168 for women. Our values are higher than the reference values for men and women, which are 2616 and 2012 kcal/day, respectively [19]. It is somewhat surprising that the TEE values were so high given that both men and women in our study took fewer steps than recommended. One explanation might be that our patients moved around relatively extensively in various everyday activities, such as cycling, housework and gardening.

In our study, women had a mean physical function score of 8, whereas men had a mean score of 11 out of 12. A score of 8 or less is of clinical importance, as it has been shown that there is an increased risk of negative health consequences and hospitalization in elderly adults with a score below 8 on the SPPB [22]. Petterson et al. [27] have suggested that women undergoing total knee arthroplasty may be more adversely affected by osteoarthritis than men, and women may have more advanced disease at the time of arthroplasty. Good balance according to the SPPB where found in our patients, whereas leg muscle strength was decreased. This is in agreement with other studies reporting that patients undergoing knee replacement lose over half of their quadriceps strength at the first assessment after the operation [28]. We found that both men and women had reduced walking speed values (0.91 and 0.81 m/sec, respectively), compared to reference values in the 65-74 years age group (1.21 m/sec for men and 1.09 m/sec for women) [29]. Gait speed is important, as it is associated with survival in older adults [30]. Several authors have proposed that gait speeds faster than 1.0 m/s suggest healthier aging while gait speeds slower than 0.6 m/s increase the likelihood of poor health and function [31,32]. Others suggest one cutoff around 0.8 meter per second [33].

We found that the correlation between physical activity (steps/day) and physical function (SPPB total score) was r = 0.43, p = 0.004, indicating that patients who walked more steps per day also had higher scores on the SPPB. We also found that the correlation between steps per day and self-selected walking speed was higher than that between steps per day and physical function in

both men and women. Our generally lower correlation coefficients in women indicate the need to measure both physical activity and physical function. The shown discordance between the amount of physical activity postoperatively and both physical function and walking speed may be explained by the fact that women do not reach the same final functional level as men do [15], and have worse pain than men both before and after arthroplasty [34,35]. In addition, Singh et al. [36] found that women had poorer function and higher dependence on walking aids than men at 2 and 5 years after knee arthroplasty.

Generalization and Limitations

The patients were recruited consecutively, resulting in a slightly skewed group in terms of gender. According to the Swedish Knee Arthroplasty Register [11], recipients of total knee replacement surgery in 2014 consisted of 60% women and 40% men. If our study had matched those numbers, the generalizability of the study may have been improved. Interestingly, however, men tended to accept participation in the study more frequently than women. Explanations for this finding may be that women may exhibit pain [35] or depression [37] to a higher degree and are therefore unwilling to participate in activities such as research studies. The study had a loss of 14%, which was considered acceptable, as dropout rates less than 10 % do not affect the quality of a study [38]. Another limitation of the study was the cross-sectional design precludes the possibility of establishing causal relationships between factors. A strength of the study was the use of an objective method for assessment of physical activity, as many previous studies have relied primarily on subjectively reported physical activity levels [39].

Clinical Application

Our results imply that patients underwent total knee replacement surgery take less steps per day than recommended, had decreased functional leg muscle strength and walk with a reduced walking speed. Physiotherapists should inform the patients to not be afraid to load the knee by walking and doing other activities. This information should be provided both preoperatively and postoperatively for patients to increase their trust in the operated joint. Physiotherapist can support behavioral changes and the maintenance of new behaviors by helping patients discover and address ambivalence regarding behavioral changes. The motivation for behavioral change must come from the person him- or herself and the advisor's role is to support and reinforce the patient in reflecting on the situation and thus reducing the resistance to the behavioral change. Women, especially seems to need strategies to support training of physical function as they have notable lower points on SPPB. Future research should focus on qualitative studies with a gender perspective exploring expectations of physical activity after surgery and on barriers for physical activity in order to achieve a better understanding in this group of patients.

Conclusion

This study demonstrated that patients undergoing total knee replacement walked fewer steps per day than recommended and had decreased walking speeds and reduced leg muscle strength, three months post-surgery. However, they had normal energy expenditure. Importantly, patients who were more physical active had better functional scores than those who were less active. To encourage physical activity among these patients, physiotherapists should inform patients both pre- and postoperatively about the importance of physical activity, intensive training of the quadriceps muscles and walking to optimize their physical activity level

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