

Superior Muscle Strength does not Lead to Increased Daily Physical Activity in TKA Patients 1 Year after Surgery: A Randomized Controlled Study

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Abstract

Background: Total knee arthroplasty (TKA) relieves pain and improves function, but only small to moderate increases in physical activity are reported after surgery. Physical activity is beneficial for promoting health, and patient expectations towards an active lifestyle after surgery are increasing. Thus, investigating objectively measured physical activity is important. The aim of the study was to investigate if increased muscle strength leads to increased physical activity in TKA patients, and to what extent TKA patients reach the recommended goal of 10,000 steps per day.

Methods: Secondary analysis from a randomized, controlled study where TKA patients <75 years were randomized to either maximal strength training of the lower extremities 3 times/week for 8 weeks and physiotherapy visit 1/week or to standard rehabilitation/telephone contact 1/week and writing home exercise logs. Physical activity in 26 TKA patients was measured by accelerometers 24 hours a day for five consecutive days 12 months after surgery. The accelerometer records duration of walking and standing time, upright time, number of steps and upright events (sit-to-stand transitions).

Results: There were no statistically significant difference between the groups in number of steps per day hours of lying and sitting, hours walking and standing or number of sit to stand transitions. Three patients performed 10,000 steps per day. BMI correlated statistically significantly with the number of sit to stand transitions.

Conclusion: Superior muscle strength 12 months after surgery in the group that performed maximal strength training did not turn to higher levels of physical activity. A low number of TKA patients reached 10,000 steps per day. More focus should be on increasing physical activity levels after TKA.

Introduction

Total knee arthroplasty (TKA) improves function and reduces pain in patients with end-stage osteoarthritis, albeit up to 20% of patients are not satisfied with the outcome [1]. Muscle strength is substantially reduced after surgery [2] and walking distance and stair climbing speed are reduced compared to healthy adults [3-5]. Patient expectations towards an active lifestyle after TKA has increased, and those expectations are not always met [6].

A recent systematic review and meta-analysis reports small to moderate improvement in objectively measured physical activity level (PA) 12 months after TKA surgery [7]. This is consistent with another systematic review, showing small changes in PA 12 months after surgery and that PA was far beyond the levels of healthy controls [8]. Adequate and regular PA can prevent a wide range of chronic diseases as cardiovascular disease, hypertension, diabetes, cancer, obesity, depression, and osteoporosis [9, 10]. Further, inactivity increases the risk for premature death [11, 12]. The World Health Organization recommends 150 minutes a week of moderate to vigorous-intensity PA to reduce the adverse effects of inactivity [13]. Further, 10,000 steps per day is a frequently published recommended goal to mitigate these negative effects [14].

Maximal strength training (MST), focusing on high loads and few repetitions, has previously shown to have positive impact on muscle force [15] and work economy [16, 17]. Reduced muscle force as a

result of unloading the limbs may influence walking patterns and walking economy negatively, which in turn may lead to decreased PA [18]. We recently published superior short- and long-term results of muscle strength and function in TKA patients performing MST compared to a group following standard rehabilitation (SR). Muscle strength in the MST group was significantly better up to 12 months after surgery [19]. To our knowledge, no study has investigated the effect of muscle strength on long-term PA in TKA patients. The aim of the study was to investigate if early post-operative strength training had positive effects on PA 12 months after surgery and to what extent TKA patients reach the recommended goal of 10,000 steps per day.

Materials and Methods

Design and participants

This randomized controlled study evaluates daily PA 12 months

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This study was a part of a randomized controlled study of 41 TKA patients <75 years, randomized to eight weeks of maximal strength training (MST) or standard rehabilitation (SR), with a 12-month follow-up period, previously published [19]. After the intervention period 10 weeks post-operatively, the patients returned to “normal” lives. Patients with TKA surgery on the contralateral knee, disability to understand verbal and written information and a travel distance of >30 minutes from the hospital, were excluded from the study. Patient characteristics are presented in Table 1. At 12 months follow-up, 14 patients in the MST group and 13 patients in the SR group were available for evaluation. One patient in the SR group did not have complete PA data and was excluded from the analysis. Patient flow through the study is shown in figure 1.

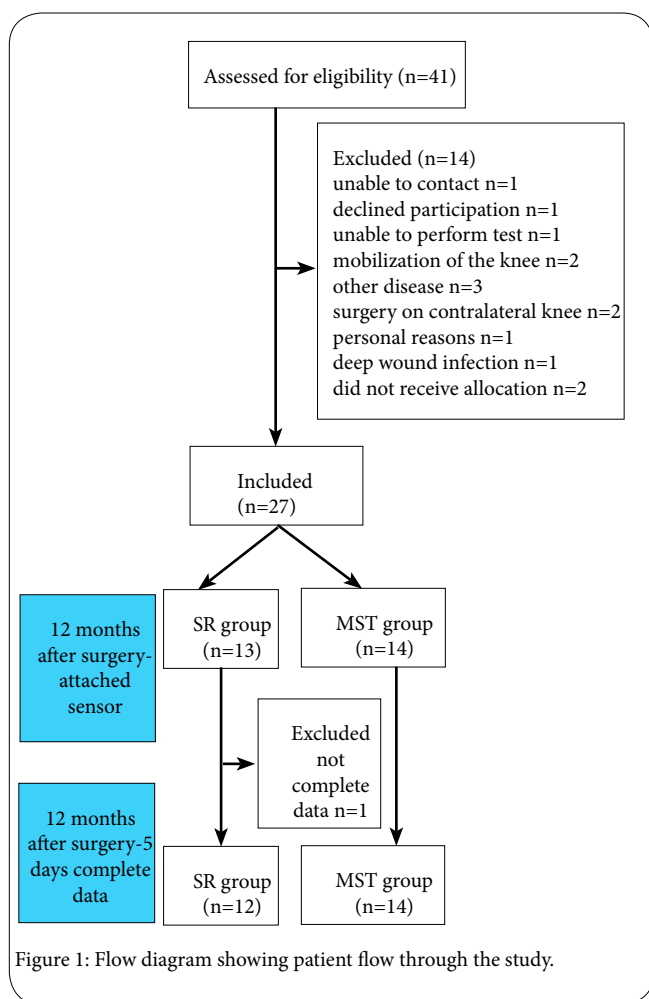


Figure 1: Flow diagram showing patient flow through the study.

	MST group n=14	SR group n=12
Age (years)	63 (52-72)	64 (45-73)
Gender (M/F)	4/10	4/8
BMI	29.4±5.0	28.2±5.2

Table 1: Baseline patient characteristics. Values are presented as ratios, mean (range) or mean (SD).

Procedures

Twelve months post-operatively, daily PA was assessed by small, body-worn, single-axis accelerometer-based activity monitors

(activPAL™, PAL Technologies Ltd., Glasgow, United Kingdom). The activePAL monitors were connected to a computer where start and duration of monitoring were preset. The activPAL was attached to the patients non-operated thigh by PALstickies (double-sided hydrogel adhesive pads) and covered by waterproof tape and worn continuously (including showering) 24 hours a day for 1 week. Activity monitoring data from five consecutive days were used for analysis. The activPAL software gives the duration of walking and standing time, and the duration of upright time by combining walking and standing time. Number of steps and number of upright events (sit-to-stand transitions) are also reported. The activPAL monitor is found to be a valid and reliable measure of walking time and posture and motion during everyday physical activities [20, 21]. The monitor also demonstrates valid measures in older individuals with impairments [22].

Statistical analysis

Statistical analysis was performed by the IBM SPSS Statistics (SPSS Statistics for Windows, version 25; SPSS Inc., Chicago, Illinois). To check for normality, Shapiro Wilk tests were used, and the data was not found to be normally distributed. χ^2 -test was used to compare gender at baseline. The non-parametric Mann-Whitney U tests were used to compare differences between groups. Spearman`s correlation was used to investigate the influence of the patient characteristics age, sex, and BMI. P-values <0.05 were considered statistically significant.

Results

Twenty-six patients had complete activity monitoring data at 12 months follow-up and were analyzed (Figure 1). There was no statistical difference in pre-operative patient characteristics.

There was no statistical difference between the groups in neither of the measures of daily PA (Table 2).

Three of the patients of the TKA patients performed >10,000 steps per day in the monitoring period (Two patients in the MST group and one in the SR group, respectively).

Pooled BMI data for both groups correlated significantly with the number of sit to stand transitions (p=0.014). No significant correlations were found between the other patient characteristics and PA.

	MST group n=14	SR group n=12	p value
Steps per day	7435±2386	6721±1938	0.462
Hours lying and sitting	17.9±2.1	17.8±1.6	0.860
Hours walking and standing	6.1±2.1	6.2±1.6	0.860
Sit to stand transitions	52±10	52±19	0.595

Table 2: Mean of 5 days physical activity for the patients in the MST group and the SR group 12 months post-operatively. Data is presented as mean and SD.

Discussion

The main finding from the present study is that the superior muscle strength 12 months after surgery in the MST group did not turn into

higher PA level in the MST group compared to the SR group. Further, only three of the TKA patients reached the recommended goal of 10,000 steps per day.

Previously published data from the same patients demonstrate that 12 months after surgery, those performing MST for two months post-operatively were significantly stronger than those performing SR [19]. Although work economy was not evaluated in the present study, MST has previously shown to improve work economy [16, 17], which may facilitate PA, because less energy consumption is needed to perform a specific task. However, there were no statistical differences in steps per day between the MST group and the SR group. The patients in the MST group and the SR group walked 7435 and 6721 steps per day, respectively. The number of steps per day is in line with the findings of others, where the TKA patients took between 5935 and 6473 [23-25] steps per day 12 months after surgery. In contrast, Walker et al. [26] report that TKA patients performed 12,358 steps per day 6 months after surgery. The patients in the study by Walker et al. [26] had high PA levels before surgery as shown by walking >10,000 steps per day. PA was measured for 1 day only, which is less than recommended. Except from age, there is limited data on the patient characteristics in the study by Walker et al. [26], so the patients might be fitter than the patients in our study, and thus explain the large difference in number of steps.

Only two patients in the MST group and one patient in the SR group met the recommended goal of 10,000 steps per day. A study by Harding et al. [27] report no increase in PA levels in TKA patients six months after surgery despite reduced pain and increased physical function. Others have found increased [25] or slightly increased activity [23] compared to pre-operative levels, but the activity level was low compared to healthy controls [25]. This shows that increased ability to be physical active, not necessarily leads to actual increased activity. An explanation might be that human behavior in general is difficult to change. Many TKA patients have lived sedentary lives before surgery because of pain and reduced knee function, and surgery does not automatically change lifestyle [27]. Further, 12 months after surgery may be too short time in order to adapt a more active lifestyle. However, findings from Vissers et al. [28] show that TKA patient's actual daily activity level did not increase from six months to four years post-operatively. Inactivity increases the risk for chronic diseases and premature death [9-12]. Consequently, more attention should be drawn to increasing daily PA in the TKA population, and not just assume that after a successful surgery, the activity level will be adequate.

Both the MST group and the SR group performed a mean of 52 sit-to-stand transitions per day, which is in line with the results from deGroot et al. [29], where the TKA patients performed 51 sit-to-stand transitions per day six months after surgery. According to a systematic review, the expected number of sit-to-stand transitions is 45 per day in adults with or without disease. Sit-to-stand transition is an important task to accomplish in everyday life, but a maneuver that often get more challenging with increasing age and pathology [30]. In the present study, BMI correlated significantly with the number of sit-to-stand transitions, but not with number of steps per day. In contrast to our findings, others have found a correlation between BMI and number of steps [25]. Hodges et al also report that obesity, together with high comorbidity levels and low PA before surgery, predicts PA levels after TKA surgery [31].

A limitation to the present study is that pre-operative PA data is not recorded. However, randomization of the groups should ensure equal groups, and pre-operative PA levels are highly influenced by pain and reduced knee range of motion. Another limitation is that sample size calculation was not based on the outcome PA. Thus, the present study may be underpowered to detect differences in PA between the groups. The study does not report the intensity of PA, which would have given valuable information. The aim of the study was however, to compare the long-term effect of MST on PA. The strength of the study is it's randomized design and that we report activity monitoring data for five consecutive days, which is adequate for achieving reliable data.

Conclusion

Better muscle strength did not lead to increased PA in the MST group compared to the SR group 12 months after surgery. Only three of the total 26 patients reached the recommended level of steps per day. The number of steps per day was not within the recommended range in either of the groups. Increased PA after surgery may demand a change in lifestyle. Therefore, more attention should be paid to promote PA in TKA patients before and after surgery in order to decrease the risk for inactivity related diseases.

Conflicts of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of the article.

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