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ORIGINAL ARTICLE

Changes in Physical Activity and Health-Related Quality of Life During the First Year After Total Knee Arthroplasty

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Objective. **Despite its impact on the overall outcome and health-related quality of life (HRQOL) after knee surgery, physical activity has not been investigated directly using accelerometry or step monitoring during the first year after total knee arthroplasty (TKA) due to osteoarthritis (OA). Therefore, the present study aimed to evaluate the development of physical activity over 12 months after surgery and its relationship to clinical outcome and HRQOL.**

Methods. **Fifty-three patients scheduled for primary TKA due to OA were measured with the DynaPort ADL monitor and a step activity monitor preoperatively and at 2, 6, and 12 months of followup. Clinical outcome and HRQOL were investigated using the American Knee Society Score (KSS) and Short Form 36 (SF-36) health survey.**

Results. **Physical activity increased significantly within 12 months of followup (from mean ± SD 4,993 ± 2,170 gait cycles preoperatively to 5,932 ± 2,111 gait cycles; $P = 0.003$). Clinical outcome and HRQOL improved from baseline (mean ± SD KSS 88.9 ± 21.4, mean ± SD SF-36 43.1 ± 18.4) to 12 months of followup (mean ± SD KSS 188.6 ± 10.9; $P = 0.001$ and mean ± SD SF-36 82.5 ± 15.9; $P = 0.001$). Physical activity parameters did not correlate with clinical outcome.**

Conclusion. **TKA offers profound improvements of physical activity for the majority of patients. Despite these improvements and the excellent clinical outcome, most patients do not reach the level of physical activity reported for healthy subjects. The activity level after treatment seems to be influenced by physical activity behavior prior to surgery rather than by the treatment itself.**

INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis. At present, more than 10% of older adults in the US are affected by knee OA (1). Many patients experiencing OA will undergo a lower extremity joint arthroplasty in their lifetime, and the number of arthroplasties will further increase in the next decades because of the aging population and an associated increasing prevalence of arthritic diseases and joint degeneration (2,3). OA is a frequent reason for disability in older adults (4), and joint arthroplasty is performed to improve health-related quality of life in patients with end-stage OA at the hip or knee (5). Common outcome variables are reduction of pain, improvement of lower extremity function, and the success of the patient's return to a normal, physically active life after surgery (5,6). In addition to radiologic findings and functional status, pain is a major criterion in the presurgical decision process and postsurgical outcome (6). While subjective and complex phenomena such as pain and quality of life influenced by OA are usually evaluated using self-report or clinical scoring methods, the reduction of physical activity in OA patients has been measured using accelerometry or step activity counts and has helped to quantify functional limitations in patients compared to healthy persons (7–9).

Nilsdotter et al (6) administered questionnaires to patients after total knee arthroplasty (TKA) and found that patients' expectations regarding postoperative physical activity are not satisfied to the same extent as their expectations regarding pain. For example, whereas before surgery 39% of patients expected to walk on even ground without limitations after their TKA, only 28% and 21% were able to walk without limitations 12 months and 5 years after

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Table 1. Demographic data of the subjects*

	Total (n = 53)	Women (n = 34)	Men (n = 19)
Age, years	65.8 ± 5.8	67.4 ± 5.3	64.2 ± 6.2
Height, cm	168.5 ± 5.4	162.7 ± 4.9	174.3 ± 5.8
Weight, kg	85.0 ± 12.3	82.6 ± 11.3	87.4 ± 13.2
BMI, kg/m^2	30.7 ± 4.1	32.7 ± 4.6	28.7 ± 3.5
KSS			
Total score	88.9 ± 21.4	85.3 ± 23.7	94.7 ± 15.9
Knee subscore	31.6 ± 14.9	31.8 ± 16.0	31.3 ± 13.5
Function subscore	57.2 ± 10.8	53.4 ± 10.1	63.3 ± 9.2
SF-36			
Total score	43.1 ± 18.4	43.2 ± 17.7	42.9 ± 20.2
Physical function	27.5 ± 15.5	27.3 ± 16.2	27.8 ± 14.8
Pain	23.6 ± 16.9	24.3 ± 18.2	22.4 ± 14.8
Gait cycles	4,992 ± 2,170	4,718 ± 1,559	5,389 ± 2,838
Locomotion, %	9.2 ± 4.9	8.3 ± 3.6	10.6 ± 6.4

* Values are the mean ± SD. BMI = body mass index; KSS = Knee Society Score; SF-36 = Short Form 36.

their TKA, respectively (6). Interestingly, none of the patients achieved a higher level of physical activity 5 years after surgery compared to what they had expected prior to surgery (6). Possible reasons for these unfulfilled expectations include unrealistic expectations, shortcomings in the rehabilitation of lower extremity function after TKA, difficulty in correctly estimating and reporting the amount of physical activity in daily life (10,11), and the theoretical relationship between physical activity and function and/or pain. Although physical activity is obviously important for TKA patients, physical activity has not been directly measured or longitudinally monitored following TKA. The aim of this longitudinal study was to measure the change in physical activity by accelerometry following TKA and to determine the relationship between physical activity and function and pain measured using clinical outcome and health-related quality of life questionnaires before surgery and 2, 6, and 12 months after TKA.

SUBJECTS AND METHODS

Subjects. All of the procedures of the current study were reviewed and approved by the institutional review board. Prior to participation, all subjects were carefully instructed and given written informed consent. Fifty-three subjects were recruited during the consulting hours in the Hospital of Ingolstadt, and their demographic data are shown in Table 1. Inclusion criteria included age 75 years or younger and indication for primary unilateral knee replacement because of OA. Exclusion criteria included pain in the contralateral knee and knee replacement on either side before treatment or within the 12-month followup period. All procedures were carried out 3 weeks before surgery and 2, 6, and 12 months after surgery. During the first 2 months after surgery, patients underwent posthospital rehabilitation, which usually follows inpatient treatment within 14 days and is covered by health insurance. Therefore, the first followup reflected the status after rehabilitation.

Clinical procedures and outcome. All subjects were treated in one hospital and received the same mobile-bearing knee implant (INNEX CR; Zimmer). Both parts of the implant were cemented in 2 cases (1 female, 1 male), the implant was partially cemented in 29 patients (24 females, 5 males), and 22 implants (9 females, 13 males) were fixed uncemented. In 9 cases, the implants were applied using NaviTrack (ORTHOsoft).

The clinical outcome was evaluated using the Knee Society Score (KSS) (12). The KSS comprised 2 subscores, the knee score and the function score. Pain, range of motion, and anteroposterior as well as mediolateral instability is summarized in the knee score. Function is evaluated by the maximum walking distance, the ability to walk stairs, and the use of walking aids such as crutches. The knee and the function score each can reach a maximum of 100 points. Therefore, the maximum score for the KSS of 200 points indicates unrestricted knee function. The total score and subscores for pain and function were calculated in this study. Health-related quality of life was assessed using the Short Form 36 (SF-36) questionnaire (13). This questionnaire consists of 36 items assigned to 8 scales (physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role, and mental health). A validated German version of the SF-36 was utilized, and code conversion, calculation, recalibration, and transformation of raw values were applied to each scale according to the manual (14). Therefore, each scale indicates the health-related status of the subject ranging from 0 (poorest status) to 100 points (best status). In this study, we focused on the scales physical functioning and bodily pain as well as on the total score given by the mean of the 8 subscores (15).

Physical activity monitoring. Two measurement devices were applied to assess physical activity. The first device, an ADL monitor (McRoberts), was applied to the subjects early in the morning during a home visit. The ADL monitor consisted of 3 acceleration sensors and a recording unit. Two acceleration sensors integrated in the recording unit were worn in a neoprene belt around the waist. The third sensor was worn in a neoprene strap on the anterior aspect of the left thigh. A cable connection allowed patients to wear the thigh sensor under their clothing. Signals of all sensors were recorded at 32 Hz, stored on a PC card, and downloaded after the measurement. The signals are analyzed using dedicated software (DynaScope; McRoberts) and summarized in a report providing absolute time and percentage of time spent in locomotion, standing, sitting, lying, and "undefined." Further technical specifications have been published previously (16). Subjects were instructed to wear the device until bedtime in the evening except when performing water activities (swimming, taking a shower). During these activities, the subjects were allowed to stop and restart the measurement as instructed by the investigator who retrieved the device on the following day. In corpulent subjects, the ability of the ADL monitor to discriminate between sitting and lying may have been impaired due to placement and fixation problems. Therefore, sitting and lying were categorized as "resting activities."

The second device was a step activity monitor (SAM; OrthoCare Innovations) that was mounted to the subject's right ankle during the visit at the subject's home. Technical specifications of the device have been described before (7) and previous reports revealed excellent accuracy (17,18). Subjects' gait characteristics were taken into account by adjusting the device for individual cadence and gait characteristics. Subjects were instructed to wear the device for 7 consecutive days from rising in the morning until bedtime in the evening. Subjects were instructed to remove the SAM for water activities (e.g., swimming or taking a shower). Subjects were not able to operate or manipulate the device because the device communicates only via a docking station and does not provide any direct feedback to the user. The number of gait cycles was stored in the internal memory in 1-minute intervals. It should be noted that the primary output parameter of the SAM is the number of gait cycles, not the number of steps, because it records only steps of the right foot. Therefore, this number should be multiplied by 2 for comparison with data collected using devices that measure single steps (e.g., step counters that are worn at the waist). After returning the SAM by mail, the data were downloaded and processed by dedicated software (StepWatch, version 3.1; OrthoCare Innovations) and exported to Microsoft Excel. In addition to the average number of gait cycles per day, gait intensity expressed as the number of gait cycles per minute was calculated according to the procedure described previously (7).

Statistical analysis. Descriptive data of clinical outcome and physical activity parameters are given in mean ± SD values. The data of the clinical outcome and physical activity monitoring were tested for normal distribution using the Kolmogorov-Smirnov one-sample test. Intrasubject differences during followup were analyzed using one-way repeated-measures analysis of variance (ANOVA) or Friedman's test, with time points as the factor. Scheffe's post hoc comparisons were applied if a significant time effect was indicated by the ANOVA. The level of significance was set a priori to alpha levels of 0.05. Linear regression models were used to detect relationships between activity parameters and clinical outcome and age, and between preoperative and 12-month followup data.

RESULTS

Two subjects dropped out of the study: one patient developed a severe secondary disease and the other withdrew the consent to participate, and their data were removed from the study. On average, the ADL monitor was worn for mean ± SD 12.3 ± 1.8 hours per day. From the total of 204 measurements, 26 measurements (13%) of the ADL monitor had to be excluded because of technical problems, insufficient measurement duration (less than 10 hours), shifting of the leg sensor during the day, and refusals of the subjects to wear the device again. Therefore, complete data sets with 4 consecutive measurements were available for 32 patients. A comparison of descriptive data and questionnaire responses revealed only one significant difference between patients with complete ADL data sets and those with missing data (the SF-36 total score at 2 months of followup; $P = 0.030$). Clinical outcome as represented by the KSS was obtained from 47 patients. The mean ± SD values of all measures at each time point and the results of the repeated ANOVA are summarized in Table 2. Scheffe's post hoc comparisons between all time points are given in Table 3.

The KSS improved from mean ± SD 88.9 ± 21.4 points preoperatively to mean ± SD 188.6 ± 10.9 points at 12 months of followup. The increase in the total scores and all subscores for knee and function were significant at all followup stages ($P < 0.001$) (Table 3). Preoperatively, the number of gait cycles correlated with the total knee score ($r = 0.3$, $P = 0.021$) and the subscore for knee function ($r = 0.5$, $P = 0.001$). At 12 months of followup, no significant correlations were found. Subjects with better total scores and subscores for knee and function before treatment did not show better total scores and subscores for knee and function after joint arthroplasty. This result is reflected by the low correlation of the total knee score before surgery and total at 12 months of followup (Figure 1).

More time was spent on locomotion 6 and 12 months after surgery ($P < 0.001$) and relatively less time was spent on resting 6 ($P < 0.013$) and 12 ($P < 0.003$) months after surgery compared to the preoperative values (Table 2 and Figure 2). The increase of standing activity after surgery compared to preoperatively did not reach significance at any of the followup stages. The proportion of physically demanding and less demanding activities assessed by the ADL monitor at each followup stage indicated that patients with a higher percentage of time spent on locomotion prior to knee surgery also showed a higher percentage of time spent on locomotion at the 12-month followup ($r = 0.5$, $P = 0.002$). The percentage of time spent on locomotion at the 12-month followup did not correlate with patient age ($r = 0$, $P = 0.946$).

The SAM was worn for mean ± SD 13.0 ± 1.5 hours per day. Eleven measurements (5%) with the SAM had to be

Table 2. Changes for clinical outcome and physical activity measures*

	Preoperative, mean ± SD	2-month followup, mean ± SD	6-month followup, mean ± SD	12-month followup, mean ± SD	F statistic	*P*
Gait cycles (n = 44)	4,993 ± 2,170	4,730 ± 1,732	5,496 ± 1,969	5,932 ± 2,111	F[2.5,107.3] = 9.3	<0.001
Locomotion (n = 32)	8.4 ± 3.6	9.8 ± 4.3	12.0 ± 5.1	12.0 ± 4.7	F[3,96] = 8.5	<0.001
Resting (n = 32)	66.2 ± 13.2	61.5 ± 14.6	56.5 ± 13.6	55.7 ± 14.6	F[3,93] = 6.1	<0.01
SF-36 (n = 47)						
Total score	43.1 ± 18.4	59.3 ± 17.8	76.6 ± 16.2	82.5 ± 15.9	F[2,92] = 81.3	<0.001
Physical functioning	27.5 ± 15.5	53.9 ± 18.4	72.6 ± 16.4	77.4 ± 17.8	F[3,138] = 108.1	<0.001
Pain	23.6 ± 16.9	53.8 ± 18.4	69.7 ± 19.3	81.2 ± 19.0	na	<0.001†
KSS (n = 47)						
Total score	88.9 ± 21.4	139.3 ± 19.0	168.1 ± 17.4	188.6 ± 10.9	F[2.0,89.7] = 355.2	<0.001
Knee	31.6 ± 14.9	72.3 ± 11.8	84.2 ± 10.2	94.2 ± 6.0	na	<0.001†
Function	57.2 ± 10.8	67.0 ± 10.9	83.9 ± 10.9	94.5 ± 8.3	na	<0.001†

* Significant differences between followup at 2, 6, and 12 months after surgery were computed by repeated analysis of variance. SF-36 = Short Form 36; na = not applicable; KSS = Knee Society Score.
† Friedman's test was applied because normal distribution was not given.

excluded because of technical problems resulting in 193 available data sets. The data of 44 patients that were successfully monitored at all 4 time points were analyzed. Patients showed a mean ± SD daily number of gait cycles of 4,993 ± 2,170 before TKA, declining to 4,730 ± 1,732 gait cycles at 2 months after surgery (not significant). Compared to the presurgery status, patients' activity increased significantly at 6 (mean ± SD 5,496 ± 1,969 gait cycles; $P = 0.025$) and 12 months after surgery (mean ± SD 5,932 ± 2,111 gait cycles; $P = 0.003$) (Tables 2 and 3). Figure 3 shows that the main increase in the number of gait cycles occurs between 6 and 12 months after surgery. After TKA, patients spent less time walking in the lowest intensity level (1–10 gait cycles/minute) but increased their time spent in moderate- (21–30 gait cycles/minute) and high-intensity (>50 gait cycles/minute) walking compared to presurgery (Table 4). Patients with a higher number of gait cycles before treatment also had more gait cycles per day after the procedure ($r = 0.5$, $P = 0.001$) (Figure 4). The number of daily gait cycles correlated minimally with patient age ($r = -0.2$, $P = 0.297$).

Complete SF-36 questionnaires were available for 47 patients. Significant improvements were revealed in the total score as well as in all subscores (Tables 2 and 3). Patients with higher total scores before surgery also had higher total scores 12 months after surgery ($r = 0.4$, $P = 0.013$). This relationship was not seen in physical functioning and bodily pain ($r = 0.2$, $P = 0.187$). At baseline, the SF-36 total scores and the subcategory bodily pain correlated with the number of gait cycles ($r = 0.4$, $P = 0.005$ and $r = 0.3$, $P = 0.044$, respectively) and the percentage of time spent on locomotion (both $r = 0.3$, $P = 0.04$). There were no significant correlations between these parameters 1 year after TKA or between the subscore physical functioning and gait cycles or locomotion before or after surgery.

DISCUSSION

The present study measured physical activity and assessed clinical outcome, including health-related quality of life in TKA patients before and after implantation, to provide detailed information about the development of the activity

Table 3. Changes within different time intervals computed by Scheffe's post hoc comparisons*

	Preoperative, 2-month followup	Preoperative, 6-month followup	Preoperative, 12-month followup	2-month followup, 6-month followup	2-month followup, 12-month followup	6-month followup, 12-month followup
Gait cycles (n = 44)	ns	ns	<0.004	<0.05	<0.001	ns
Locomotion (n = 32)	ns	<0.01	<0.001	ns	ns	ns
Resting (n = 32)	ns	<0.05	<0.01	ns	ns	ns
SF-36 (n = 47)						
Total score	<0.001	<0.001	<0.001	<0.001	<0.001	ns
Physical functioning	<0.001	<0.001	<0.001	<0.001	<0.001	ns
Pain	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
KSS (n = 47)						
Total score	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Knee	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Function	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

* ns = not significant; SF-36 = Short Form 36; KSS = Knee Society Score.

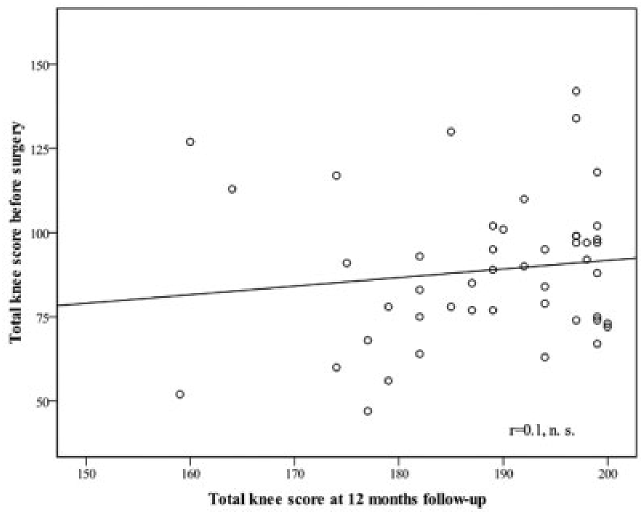

Figure 1. Total American Knee Society Scores before surgery compared to 12 months of followup. n. s. = not significant.

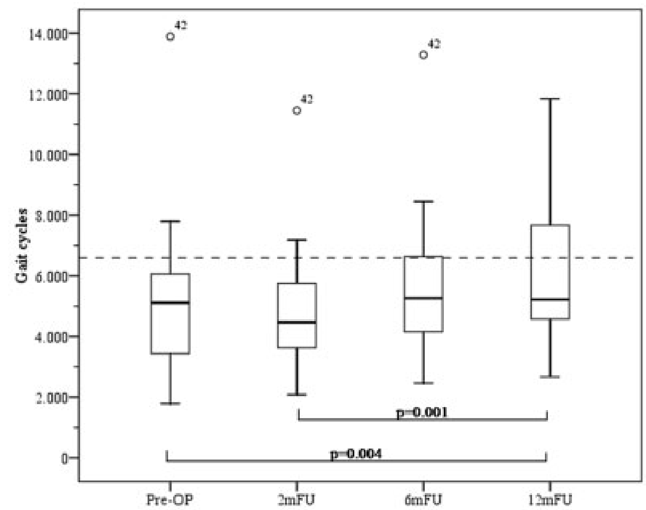

Figure 3. Number of daily gait cycles (n = 44) preoperatively (Pre-OP) and at 2 (2mFU), 6 (6mFU), and 12 (12mFU) months of followup after surgery. The **broken line** shows the average gait cycles per day of healthy subjects (7).

level and its relationship to clinical outcome and health-related quality of life after joint replacement. To our knowledge, this is the first study to apply reliable measurement tools for week-long assessments and repeated measurements of activity level during the first year after TKA. While only 32 patients with 4 consecutive measurements of percentage of locomotion and resting were available, the clinical results did not differ significantly between patients with complete data sets and those with missing data. Therefore, it can be assumed that the reported data are representative for the entire study sample.

Six months after surgery, patients increased their percentage time spent on locomotion to a higher degree (44.5%) than patients assessed by de Groot and colleagues (12.3% [19]), even when accounting for the extended measurement duration (24 hours) of the latter study. Furthermore, the percentage of time spent on locomotion in these patients at 6 and 12 months after TKA was higher than in patients after extremity salvage surgery (20) or hip arthroplasty (21). Thus, these results suggest that patients in this study were able to substantially increase their percentage of time spent on locomotion following their TKA.

Before surgery, the number of gait cycles per day (4,993 gait cycles) compared well to another group of hip and knee patients (4,782 gait cycles) measured prior to surgery in a different region of Germany (7). The decrease of the number of gait cycles 2 months after surgery (4,730 gait cycles) supports the findings of previous studies concluding that patients leave the hospital with limited function compared to the preoperative status due to the trend of being discharged early from the hospital (22). Furthermore, our findings indicate that patients ambulate less after the initial rehabilitation period than before surgery. During the subsequent 4 months, patients increase their number of daily gait cycles significantly. Twelve months after surgery, the average number of gait cycles per day (5,932 gait cycles) exceeded values reported for hip patients after joint replacement (5,275 gait cycles [23]) and those reported for patients with well-functioning hip arthroplasties (5,219 gait cycles [24]) that had been measured with the same device. These results suggest that the implants were subjected to an average load of 2.2 million loading cycles within 12 months following implantation. However, even 12 months after surgery, the majority of TKA patients did not reach the number of gait cycles or the amount of high-intensity walking that was previously reported for healthy subjects (6,616 gait cycles [7]).

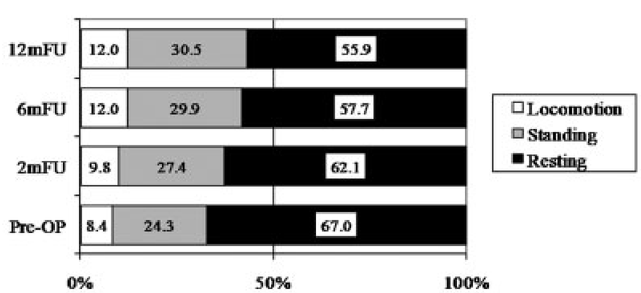

Figure 2. Changes in physically demanding (locomotion, standing) and less demanding activities (resting) after total knee arthroplasty (n = 32). Numbers indicate the mean time spent in each category preoperatively (Pre-OP) and at 2 (2mFU), 6 (6mFU), and 12 (12mFU) months of followup after surgery. Missing amounts to 100% are caused by unclassifiable signals.

In most studies on total knee replacement, the clinical outcome is assessed using the KSS (25). Before surgery, scores in our patients were similar to those reported for a reference group of patients similar in age experiencing knee OA and scheduled for treatment with a fixed- or mobile-bearing implant (26). Twelve months after surgery, our patients exceeded the 12-month followup values of the reference group (26). Our patients showed lower health-related quality of life scores prior to surgery, but exceeded the values reported for fixed- and mobile-bearing groups assessed 2 years after the procedure (26). Therefore, the clinical outcome and SF-36 data suggest that our patients benefited similarly or slightly more from TKA than usually expected. The discrepancies might be caused by differences in surgical techniques, cross-cultural factors in-

Table 4. Changes in gait intensity (n = 44)*

Gait cycles per minute	Preoperative	2-month followup	6-month followup	12-month followup	*P*†
1–10	50.8 ± 8.5	49.3 ± 7.6	47.9 ± 7.6	46.3 ± 7.2	0.001
11–20	25.9 ± 3.3	26.4 ± 3.2	26.4 ± 3.4	26.7 ± 3.2	0.11
21–30	12.4 ± 3.6	12.9 ± 3.4	13.6 ± 3.4	14.5 ± 3.2	0.001
31–40	5.8 ± 3.3	6.0 ± 2.5	6.5 ± 2.8	6.6 ± 2.7	0.19
41–50	3.5 ± 2.4	4.0 ± 3.6	3.6 ± 2.4	3.8 ± 2.9	0.48
>50	1.5 ± 2.1	1.3 ± 2.2	2.0 ± 2.5	2.2 ± 2.3	0.01

* Values are the mean ± SD percentage spent in each gait intensity level while walking preoperatively and at 2, 6, and 12 months of followup after surgery.
† *P* values are calculated between preoperative and 12-month followup.

volved in using a questionnaire, or a potential bias in the recruitment of the patients. However, the patients investigated in the present study do not represent patients with exceptional outcome.

The minimum clinically important difference (MCID) for total knee replacements is at least 10 points for the SF-36 in patients following TKA (27). The mean differences between time points found in our study were greater than 16 points and are therefore clinically important. While no information on MCID for the KSS is available, a review article by Singh et al (28) on health-related quality of life assessment stated that a difference of 61% of 1 SD in KSS for TKA patients is a moderately large and almost certainly clinically meaningful effect size. The mean differences in the KSS between time points in our study ranged between 70% and 180% of 1 SD. Therefore, it can be assumed that these differences are clinically important.

In general, the results on physical activity, clinical outcome, and health-related quality of life revealed a steady increase of all parameters that might improve slightly even beyond 12 months after surgery. Because of the moderate correlations between preoperative and postoperative physical activity, a higher physical activity level before surgery serves as a moderate indicator for a higher activity level 12 months after surgery. Previous studies have shown that preoperative pain and functional status predict postoperative pain and functional ability assessed by questionnaires and/or scores to a small extent (22,29). In contrast, in our study, patients with better clinical scores and health-related quality of life before treatment did not necessarily achieve better scores after the procedure. One possible explanation for this result is the relatively low number of patients investigated in this study compared to the number of patients needed for finding a significant but small correlation between pre- and postsurgical outcome. Therefore, the activity level of patients after treatment seems to be influenced by their general lifestyle and physical activity behavior before surgery rather than by the treatment itself. The limited correlations between activity parameters and age in this specific population did not support the common assumption that younger subjects are more active than older subjects.

Interestingly, the correlations between physical activity parameters and clinical outcome and health-related quality of life before surgery disappeared 12 months after surgery, although physical activity is an important category in the KSS and SF-36. Therefore, self-reported physical activity seems to be more accurate if it is painful, i.e., while walking with a degenerated knee. If pain is reduced after surgery, a patient's ability to recall their actual amount of physical activity may be diminished because they perceive it less consciously in their daily life. Furthermore, it is suggested that psychological determinants influence self-reported pain and functional outcome to a greater extent than medical and baseline variables in TKA (22). On one hand, this phenomenon could partially explain the discrepancy between patients' preoperative expectations and their postoperative satisfaction. On the other hand, even 12 months after TKA the patients do not perform locomotion to a similar extent and intensity as their healthy peers. Postsurgical physical activity might also be influenced by the activity recommendations of the surgeons. Commonly, surgeons discourage higher-impact activities such as jogging or playing singles tennis after TKA, although it has been shown that these recommendations are not based on strong scientific evidence (30). Consequently, if physical activity levels comparable to healthy subjects are expected by the patients, further initiatives are necessary to improve patients' activity levels after surgery. This might include an improved and dedicated treatment protocol with motivational strategies toward taking advantage of the restored

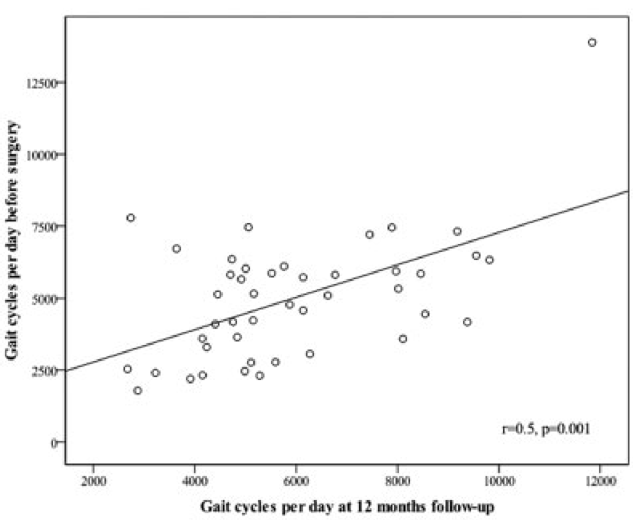

Figure 4. Gait cycles per day before surgery compared to gait cycles per day after 12 months of followup.

locomotor function, including the development of evidence-based activity recommendations. Different approaches based on motivational strategies (e.g., enhancing self-efficacy, promoting an active lifestyle), improvement of musculoskeletal function, or implementation of feedback instruments (e.g., step counters) could be evaluated regarding their impact on physical activity, clinical outcome, and health-related quality of life.

TKA provides the possibility to return to a physically active lifestyle and to improve health-related quality of life for the majority of patients experiencing knee OA. However, 12 months after surgery, most patients did not achieve the physical activity level of healthy subjects. Therefore, prospective improvements of treatment should include a more pronounced focus on the activity level of the patients after TKA and employ appropriate methods to measure physical activity directly.

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AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Brandes had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Brandes, Hillmann, Rosenbaum.

Acquisition of data. Brandes, Ringling, Winter.

Analysis and interpretation of data. Brandes, Ringling, Hillmann, Rosenbaum.

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