

FUNCTIONAL IMPROVEMENT UP TO SIX MONTHS AFTER TOTAL KNEE ARTHROPLASTY: MEASURED BY KNEE RANGE OF MOTION AND SELF-REPORTED QUESTIONNAIRE

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The primary aim of this study was to assess knee range of motion (ROM) as well as patients' reported pain, stiffness and function up to six months after total knee arthroplasty (TKA). The secondary aim was to analyze the extent to which knee ROM correlates with patient-rated outcome. A prospective study included 60 patients with primary TKA for osteoarthritis, admitted at Physical Medicine and Rehabilitation Clinic from April 2009 to October 2014. The patients were evaluated at 4 time points: at admission and at discharge, as well as at follow-up at 3 and at 6 months after surgery. The outcome parameters included: active knee ROM, as well as pain, stiffness and function according to self reported Western Ontario and McMaster Universities Osteoarthritis (WOMAC) questionnaire. Statistically highly significant improvement in flexion and extension was observed from admission to all other assessment time points ($p < 0.001$). Also, statistically significant improvement of all three WOMAC subscales (pain, stiffness and function) was found between all assessments points ($p < 0.001$). According to values of Spearman correlation coefficient, there was significant negative correlation of flexion with all WOMAC subscales at all assessment points, whereas correlation of extension with any assessed outcome parameter was without significance.

It can be concluded that in TKA patients all outcome measures improved significantly from admission to 6 months follow-up. Knee flexion ROM negatively and moderately to strongly correlated with pain, stiffness and function, whereas correlation of extension with any assessed outcome measure was without significance. *Acta Medica Mediana* 2015;54(4):52-58.

Key words: total knee arthroplasty, functional outcome, knee range of motion

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Introduction

Knee arthroplasty is an elective surgical procedure in which the damaged knee joint is replaced by a prosthetic implant. Total knee arthroplasty (TKA) is considered to be a safe, cost-

effective option that can provide significant pain relief as well as improved knee function and quality of life (1-8). The main clinical indication for TKA is advanced osteoarthritis (OA) and approximately 97% of TKA are performed for knee osteoarthritis (1, 8, 9). Mostly, knee OA is treated in a conservative manner, but when conservative treatment fails to alleviate knee joint pain and dysfunction knee arthroplasty is performed (10).

Knee arthroplasty is a technically demanding surgical procedure due to complex shape and biomechanics of the knee joint. From the development of TKA to the present day there has been an improvement of surgical techniques, as well as the implant technology. Over the last 20 years the number of knee arthroplasty has increased significantly in developed countries (11) and is predicted to further increase, so it is projected to result in a rate of nearly half a million TKA performed annually in the United States by the year 2030 (10).

The primary goals of arthroplasty are to relieve pain and improve function (2, 12). The outcome of TKA depends on a well stated indi-

cation for a surgery, a well done surgery, as well as on a well timed and adequate rehabilitation treatment. The outcome of knee arthroplasty can be measured by a variety of instruments (1). Knee ROM is an objective measurement which detects the functional changes that appear over time and it is an important component of the assessment of TKA outcome (1, 2, 9). During the last 15 years there has been a shift in outcome assessment from simply recording the physician-based success to the assessment of the outcomes of TKA from the perspective of patients (13). These new assessment questionnaires allow patients to rate their own health, thereby placing them at the center of outcome assessment. One of the most commonly used questionnaires is the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), a disease specific questionnaire, designed in 1982 to assess the function of hip and knee degenerative diseases (14). It is a short and simple instrument which is filled by the patient and which assesses pain, stiffness and knee function. It has been validated in numerous studies and accepted as a reliable and disease - specific indicator of outcomes after TKA (11).

According to self-reported questionnaires, most patients report improvement after surgery with regard to pain and physical functioning. The greatest improvement is achieved by 6 months after surgery (5, 10, 13) while minor additional improvement is achieved up to one or two years after surgery (7, 13).

Therefore, the primary aim of this study was to assess knee ROM as well as patients' self-reported pain, stiffness and function up to six months after TKA. The secondary aim was to analyze the extent to which knee ROM correlates with patient-rated outcome.

Patients and methods

A prospective longitudinal cohort study recruited 62 patients with TKA, admitted to post acute inpatient rehabilitation at Physical Medicine and Rehabilitation Clinic from April 2009 to October 2014. The inclusion criteria were: primary unilateral TKA for OA, willingness and ability to comply with the follow-up evaluations, ability to ambulate with/without the use of an assistive device prior to surgery and completed subacute inpatients rehabilitation. The exclusion criteria were: cognitive impairment, revision TKA or the previous lower limb surgery, neurological and musculoskeletal diseases that limit physical functioning.

All patients had undergone the cemented TKA in the same Orthopaedic Clinic and were admitted to our clinic between 6 and 12 days after surgery. They had 21 days of inpatient rehabilitation according to the standard protocol adapted to each patient's individual tolerance level. It included cryotherapy, kinesitherapy and the use of a continuous passive motion machine. Kinesitherapy was focused on ROM, muscle strength-

ening, proprioception and gait. Also, patients were educated about the importance of regular exercise for a better outcome after discharge from rehabilitation unit.

None of the patients refused to participate. At the beginning of the study there were 62 patients. Two of the patients were excluded. One patient was discharged from the rehabilitation unit due to the development of deep venous thrombosis, and the other patient developed an infection caused by methicillin-resistant *Staphylococcus aureus* with the increased factors of inflammation so that she was discharged and transferred to the Orthopaedic Clinic. Thus, 60 patients remained and were included in the study. There were no drop-outs from the first assessment to the follow-up examination 3 and 6 months after surgery.

All the patients were evaluated at 4 time points: at admission, at discharge as well as at follow-up at 3 and 6 months after surgery. The demographic and health data that included age, sex, body mass index (BMI) and comorbidities were recorded at the admission of the patients. For each patient the total number of comorbidities was calculated.

Outcome measures

The outcome parameters included:

1) Knee ROM: Active flexion and extension ROM was measured to the nearest 5 degrees using the standard full-circle goniometer, with the patient in a supine position with the contra-lateral extremity fully extended. Flexion and extension ROM were measured and recorded in degrees according to the method suggested by Ruf and Wyldman 1999 (15). If the patient's leg cannot be fully extended, i.e. it lacks 10° of full extension ROM, it is to be recorded as - (minus)10°. Knee ROM was measured at admission, at discharge and at follow-up 3 and 6 months after surgery. The same investigator measured ROM at all assessment time points.

2) Pain, stiffness and function were assessed according to self reported WOMAC questionnaire (Likert version 3.1) on the basis of patients self-assessment (14). The WOMAC comprises 3 subscales: pain (2 items), stiffness (2 items) and function (17 items), with each item scored on a five-point Likert scale (0-4). Each subscale is summed, 0-20 for pain, 0-8 for stiffness, and 0-68 for function. There is also a total WOMAC score (WOMAC Index) that reflects overall disability. It is calculated by summing the scores of the three subscales and produces a score between 0 and 96. Lower WOMAC scores indicate lower level of symptoms or physical disability. Raw scores for each subscale were analyzed without transformation. WOMAC questionnaire assesses pain, stiffness and functional status in the last 48 hours before the questionnaire has been filled (14).

WOMAC subscales for pain and stiffness were completed at admission and at discharge

from rehabilitation unit, and at follow-up 3 and 6 months after surgery. The WOMAC function subscale was completed at 3 and 6 months, and at those time points total WOMAC score was calculated. WOMAC questionnaire was filled by patients themselves. When the administration was done, one of the investigators checked whether all fields were filled in and in case they weren't, the questionnaire was immediately handed back to supply the missing answers.

Statistical analysis

The continuous variables were described by mean±standard deviations and by medians. For the dichotomous variables, absolute numbers and percentages were given. The distributions of the continuous variables were assessed for normality by Kolmogorov-Smirnov test. Because a distribution of data was not normal, a Wilcoxon Signed-Ranks was used to compare cases of two related observations, and Spearman (ρ) correlation coefficient was used to analyze associations between continuous variables. A chi-square test was used to compare proportions of categorical variables between groups. P values less than 0.05 were considered significant. The calculations were carried out using the SPSS statistical package version 15.0.

Results

The study included 60 patients. Demographic and health data of patients with TKA in terms of sex, age, BMI, average number of comorbidities and presented types of comorbidities are summarized in Table 1.

Table 1. Characteristics of patients

| | Patients with TKA (n=60) |
|--------------------------|------------------------------|
| Age | 67.33±6.91 (67.00) |
| Sex (Male/Female) | 16 (26.67%) / 44 (73.33%) |
| Body mass index (BMI) | 30.49±5.89 (29.65) |
| Comorbidity number | 1.82±1.02 (2.00) |
| Number of patients with: | |
| Heart disease | 21 (35.00%) |
| Diabetes | 21 (35.00%) |
| Hypertension | 50 (83.33%) |
| Other comorbidities | 18 (30.00%) |

NOTE: Data are given as absolute numbers -n, means±SD (medians), frequencies and percentages; TKA -total knee arthroplasty

In our cohort of patients, statistically highly significant flexion increase was observed between all assessment time points ($p<0.001$). Also, knee extension was significantly improved from admission to other assessment time points ($p<0.001$). Knee extension was also significantly improved

from discharge to follow-up at 3months, but at lower level of significance ($p<0.05$) and at 6 months after surgery ($p<0.01$) (Table 2).

Table 2. Improvement in knee flexion and extension up to six months after TKA

| | |
|---------------------|---------------------------|
| Flexion (degrees) | |
| Admission | 61.75±15.65(60.00) |
| Discharge | 81.42±19.40(82.50) a*** |
| 3-month follow-up | 91.67±16.92(95.00)ab*** |
| 6-month follow-up | 101.08±16.34(105.00)ab*** |
| Extension (degrees) | |
| Admission | -6.00±5.95(-5.00) |
| Discharge | -3.08±4.02(0.00) a*** |
| 3-month follow-up | -2.33±3.38(0.00) a***b* |
| 6-month follow-up | -2.17±3.24(0.00) a***b** |

NOTE: Data are given as absolute numbers - n, means±SD (medians), frequencies and percentages; TKA - total knee arthroplasty; a - vs admission, b - vs discharge; * - $p<0.05$, ** - $p<0.01$, *** - $p<0.001$

Also, statistically significant improvement of all three WOMAC subscales (pain, stiffness and function) was found between all assessments points at highest level of significance ($p<0.001$) (Table 3).

Table 3. Improvement in WOMAC scores up to six months after TKA

| | |
|-------------------|--------------------------|
| WOMAC Pain | |
| Admission | 11.03 ±2.43(10.00) |
| Discharge | 7.38 ±2.20(7.00) a*** |
| 3-month follow-up | 5.33 ±2.13(5.00) ab*** |
| 6-month follow-up | 4.88 ±2.10(4.00) ab*** |
| WOMAC Stiffness | |
| Admission | 5.60 ±1.43(6.00) |
| Discharge | 4.77 ±1.29(5.00) a*** |
| 3-month follow-up | 3.93 ±1.39(4.00) ab*** |
| 6-month follow-up | 3.22 ±1.21(3.00) ab*** |
| WOMAC Function | |
| 3-month follow-up | 26.83 ±11.89(26.00) |
| 6-month follow-up | 21.23 ±10.45(20.00) c*** |
| WOMAC Index | |
| 3-month follow-up | 36.30 ±13.63(34.50) |
| 6-month follow-up | 29.33 ±13.12(27.00) c*** |

NOTE: Data are given as absolute numbers -n, means±SD (medians), frequencies and percentages; TKA -total knee arthroplasty; WOMAC - Western Ontario and McMaster Universities Arthritis Index 0-96 (with zero being the best result); a -vs admission, b -vs discharge, c -vs 3 months; *** - $p<0.001$

According to values of Spearman correlation coefficient, there was significant negative correlation of flexion with all WOMAC subscales at all assessment points, whereas correlation of extension with assessed outcome measures was without significance (Table 4).

Table 4. Correlation (Sperman's rho) between WOMAC subscales and knee flexion and extension up to six months after TKA

| | Flexion | Extension |
|-------------------|-----------|-----------|
| WOMAC Pain | | |
| Admission | -0.29 * | -0.22 |
| Discharge | -0.44 *** | -0.08 |
| 3-month follow-up | -0.54 *** | -0.09 |
| 6-month follow-up | -0.54 *** | -0.09 |
| WOMAC Stiffness | | |
| Admission | -0.35 ** | -0.02 |
| Discharge | -0.40 ** | 0.07 |
| 3-month follow-up | -0.40 ** | 0.09 |
| 6-month follow-up | -0.38 ** | 0.14 |
| WOMAC Function | | |
| 3-month follow-up | -0.44 *** | -0.07 |
| 6-month follow-up | -0.56 *** | -0.06 |
| WOMAC Index | | |
| 3-month follow-up | -0.46 *** | -0.03 |
| 6-month follow-up | -0.59 *** | -0.05 |

NOTE: TKA –total knee arthroplasty; WOMAC –Western Ontario and McMaster Universities Arthritis Index 0-96 (with zero being the best result); * – $p < 0.05$, ** – $p < 0.01$, *** – $p < 0.001$

The correlation between flexion and WOMAC pain subscale was significant and weak at admission ($r=0.29$; $p < 0.05$), while the strength of correlation varied from -0.44 to -0.54 at the other assessment points ($p < 0.001$). Correlation between flexion and WOMAC stiffness subscale was negative and ranging from -0.35 to -0.45 at all assessment points ($p < 0.01$). Flexion was significantly and negatively correlated with WOMAC function subscale and WOMAC index at 3 and at 6 months follow-up assessments ($p < 0.001$).

Strong negative and statistically significant correlation was found between flexion and WOMAC pain subscale at 3 months ($r=0.54$; $p < 0.001$) and at 6 months after surgery ($r=0.54$; $p < 0.001$), as well as between flexion and WOMAC function subscale ($r=0.56$; $p < 0.001$) and WOMAC index ($r=0.58$; $p < 0.001$) at 6 months after surgery.

Discussion

Our sample had a higher proportion of women, which is commonly found in studies involving TKA due to osteoarthritis (5, 9, 11, 16). The average age of patients at the time of surgery was 67, that is similar to other authors findings (4, 5, 9, 11, 17), while the average age was over 70 in some other studies (2, 7, 16). The average BMI of 30.5 kg/m^2 was observed in our patients, that is approximately the same as observations in the majority of other studies (4, 5, 7, 9-11, 18). Evgeniadis et al. (8) found higher BMI of approximately 34 kg/m^2 , while the average BMI was lower according to some authors (2, 6, 17, 18). Comorbidity is considered to have a significant impact on the functional outcome after TKA (5). The average number of comorbidities in our pa-

tients was about 2, hypertension being present in more than 80% of them. Harmer et al. (11) observed hypertension in 71% of the patients. Crosbie et al. (5) found that 50% of patients had 3 or more comorbidities.

One of the goals of TKA is to restore ROM to a functional range (9). It is well known that ROM affects the patients' functional ability after TKA and ROM is widely used to describe the outcome in patients undergoing TKA (9). Knee flexion of at least 90° is essential for performing some usual daily activities (9), while a minimum of 110° of flexion is needed to successfully complete activities of daily living such as walking normally, rising from a chair and ascending/descending stairs (12). Liao et al. (2) pointed out that at least knee flexion of 120° is needed for performing some high-flexion activities such as squatting and kneeling. Many efforts have been made to improve ROM, but Thomsen et al. (12) found out that increase of flexion beyond 110° did not result in significantly greater satisfaction of TKA patients.

In our patients, significant improvements in knee ROM occurred over time with each subsequent assessment up to 6 months after TKA. The average active knee flexion observed at 6 months assessment after surgery was 101° , consistent to findings of Crosbie et al. (5), but higher than the average flexion of 95° measured by Beaupre et al. (19). Many other authors found significantly greater average active or passive knee flexion, even above 110° (2, 4, 6, 10, 12, 13). Slightly greater flexion was found by some other authors (9, 11), but the difference between our study and the study of Harmer et al. (11) is that they measured passive knee ROM, that is known to be a few degrees higher than the active, while Collins et al.

(9) measured flexion in sitting position.

The average active knee extension observed in our study at 6 months follow-up was about -2° , that is approximate to the average active knee extension found by other authors (4, 10, 11), while Collins et al. (9) found extension of -4.5° , measured in standing position.

In this study WOMAC questionnaire (14) was used to evaluate the self-perceived functional status of participants. The WOMAC has excellent reliability, validity, and responsiveness (11, 16). A number of various validated transformations and modifications of WOMAC scores are reported in the literature (20). For the interpretation of the result of any trial, clear report of the scale used and the score range is very important (20). In our study raw WOMAC scores for each subscale were analyzed without transformation.

In our patients, significant improvements in terms of WOMAC pain, stiffness and function subscales occurred up to 6 months after surgery. Our findings are consistent to other authors' findings that the recovery after knee arthroplasty is time-dependent (7, 10, 13). The last follow-up outcome assessment in our study was performed 6 months after surgery because it was expected that patients would achieve most of improvement in flexion, pain and physical function by that time (2, 4, 6, 7, 10, 13, 19). According to some authors' findings, further slight improvement can be expected during 2 years after surgery (7). It is consistent to findings of Nerhus et al. (13), who assessed the time course of functional outcome over the first 4 years after TKA and concluded that most of the expected improvement in pain and function is achieved up to 6 months after surgery, but some further improvement occurred up to 2 years, and then declined towards 4 years.

Regarding WOMAC pain, our study showed progressive decrease in pain score up to 6 months after surgery, when it was 4.88 on the average. It is in accordance with the results of the other authors, who also found progressive decrease of pain up to 6 months, with small or significant changes after 6 months up to one to two years (13, 17, 19). In contrast to these findings, Mizner et al. (10) have shown significant decrease of pain during the first 3 months, while there was no significant change between the 3 and 6 month

examination, similar to Harmer et al. (11) showing that WOMAC pain score was significantly improved up to 8 weeks and reached a plateau thereafter.

Regarding WOMAC stiffness and function subscales, significant improvement was found up to 6 months after TKA, when WOMAC stiffness score was 3.2, and WOMAC function score 21.2. Most of the authors also found substantial improvement of these WOMAC subscales over the period of 6 months after TKA (2, 10, 11, 19). In terms of all three WOMAC subscales, our results were better than findings of Hartley et al. (16), but worse than other authors' results (5, 11, 17, 19).

We found that knee flexion ROM was moderately to strongly correlated with all three WOMAC subscales at all assessment points, whereas correlation of extension with any assessed outcome measure was without significance. In contrast to our results, Park et al. (17) reported that knee flexion after TKA was only weakly correlated to pain and function. Miner et al. (18) also found a relatively weak correlation of knee flexion ROM with function 1 year after TKA. They found that WOMAC function was only significantly deteriorated when maximum flexion was less than 95° (18).

Conclusion

In this cohort of TKA patients all outcome measures including knee flexion and extension ROM, as well as self reported pain, stiffness and function improved significantly from admission to rehabilitation unit up to 6 months assessment point. Knee flexion ROM negatively and moderately to strongly correlated with pain, stiffness and function, whereas there was no significant correlation of extension with any assessed outcome measure. The physiatrists need to consider the correlation we found when designing therapeutic exercise program after TKA in order to achieve greater flexion ROM, because of significant correlation of flexion ROM with self reported pain, stiffness and function. Future larger longitudinal cohort studies are needed to determine the extent to which knee ROM correlates with functional outcome.

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Original article

UDK: 617.583-089.844:615.8
doi:10.5633/amm.2015.0408**POBOLJŠANJE FUNKCIJE TOKOM PRVIH ŠEST MESECI NAKON
TOTALNE ARTROPLASTIKE KOLENA: MERENO NA OSNOVU
OBIMA POKRETA KOLENA I UPITNIKA ZA SAMOPROCENU***Mirjana Kocić^{1,2}, Anita Stanković¹, Dragan Zlatanović¹, Tamara Ćirić³,
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Ova studija je imala kao primarni cilj procenu ishoda totalne artroplastike kolena putem merenja obima pokreta kolena, kao i na osnovu upitnika za samoprocenu bola, ukočenosti i funkcije, tokom prvih 6 meseci nakon operacije. Sekundarni cilj je bio da se analizira veličina korelacije između obima pokreta kolena i parametara samoprocene ishoda. Prospektivna studija je obuhvatila 60 pacijenata sa primarnom totalnom artroplastikom kolena usled gonartroze, primljenih na Kliniku za fizikalnu medicinu i rehabilitaciju između aprila 2009. godine i oktobra 2014. godine. Evaluacija ishoda artroplastike je vršena četiri puta: na prijemu i na otpustu sa klinike, kao i na kontrolnim pregledima tri i 6 meseci nakon operacije. Parametri procene ishoda su obuhvatili: aktivni obim pokreta kolena, kao i samoprocenu bola, ukočenosti i funkcije na osnovu Western Ontario and McMaster Universities Osteoarthritis (WOMAC) upitnika. Na otpustu i na kontrolnim pregledima nakon tri i 6 meseci u odnosu na prijem, došlo je do visoko signifikantnog poboljšanja ($p < 0,001$). Takođe je nađeno statistički visoko značajno poboljšanje sve tri WOMAC podskale između svih perioda evauacije ishoda ($p < 0,001$). Utvrđena je signifikantna i negativna korelacija fleksije sa svim WOMAC podskalama u svim periodima merenja, dok su korelacije ekstenzije sa ispitivanim parametrima samoprocene ishoda bili bez značaja. Može se zaključiti da su se svi parametri za procenu ishoda statistički značajno progresivno popravljali od prijema pacijenata na rehabilitaciju do kontrolnog pregleda 6 meseci nakon operacije. Utvrđena je negativna i umerena do jaka korelacija obima pokreta fleksije kolena sa bolom, ukočenošću i funkcijom, dok je korelacija ekstenzije sa navedenim parametrima ishoda bila bez značaja. *Acta Medica Mediana* 2015;54(4):52-58.

Ključne reči: totalna artroplastika kolena, funkcionalni ishod, obim pokreta kolena

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