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Functional Outcome of Preoperative Exercises on Range of Movements Following TKA: A Prospective Comparative Study

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Background. The range of motion prior to total knee arthroplasty (TKA) is a key determinant of the postoperative range of motion. The chance that the accompanying stiffness of the extensor mechanism may lead to limited flexion following surgery increases with how restricted the preoperative range of motion was. It would make sense to enhance knee ROM before surgery in order to optimize flexion following TKA. Final flexion following TKA is affected by a number of factors, although preoperative range of motion is the most important.

The aim of the study — to evaluate the functional performance and efficacy of the preoperative exercise programme on the osteoarthritic knee during the exercise period, following arthroplasty, during immediate postoperative recovery, and at 1, 3, 6 and 12 months after surgery.

Methods. For the study, 156 patients with knee arthritis were collected over a period of one and a half years. In this prospective study, they were divided into a treatment group and a control group. Preoperative knee exercise was given to 78 patients for at least one month. Prior to and following the treatment group's workouts, all patients were observed. The time in days before reaching 90° of knee flexion and the length of the hospital stay were the data that were gathered. At 4 weeks, 3 months, 6 months, and 1 year, each subject had their knee ROM and KSS reevaluated.

Results. Knee workouts were unquestionably helpful in achieving early knee flexion up to 90° in comparison to that of the control group. When the treatment group was compared to the control group, knee flexion to about 90° and more was attained in about 4 weeks; this difference was statistically significant ($p<0.01$). However, there were no appreciable variations in the knee range of motion achieved on long-term follow-up for 6 months and a year.

Conclusion. In conclusion, prehabilitation significantly improves the KSS for the treatment group both before surgery and three months after surgery. Exercises done before to surgery help patients recover more quickly from TKA and may speed up the process of achieving a good flexion and extension range of motion. However there is no significant difference in functional outcome after one year post surgery in both groups.

Keywords: osteoarthritis, prehabilitation exercise, functional outcome, TKA.

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Влияние физических упражнений в предоперационном периоде на объем движений в коленном суставе после тотального эндопротезирования: проспективное сравнительное исследование

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Актуальность. Объем движений в коленном суставе перед тотальным эндопротезированием является основополагающим фактором, влияющим на функциональные результаты после операции. Чем больше выражена контрактура на фоне ригидности мышц разгибателей до вмешательства, тем выше риск возникновения ограничений сгибания в послеоперационном периоде. В связи с этим представляется целесообразным увеличить предоперационный объем движений для оптимальной работы мышц-сгибателей после выполнения тотального эндопротезирования коленного сустава (ТЭКС). Сгибание в коленном суставе после тотального эндопротезирования зависит от множества факторов, среди которых самым важным является объем движений в предоперационном периоде.

Цель исследования — оценить функциональные показатели и эффективность предоперационной программы упражнений при остеоартрозе коленного сустава во время их выполнения, в период послеоперационного восстановления после эндопротезирования, а также через 1, 3, 6 и 12 мес. после операции.

Материал и методы. За полтора года в исследование были включены 156 пациентов, получивших хирургическое лечение по поводу артроза коленного сустава. Они были поделены на 2 проспективные группы — основную и контрольную. Семидесяти восьми пациентам в предоперационном периоде проводились физические упражнения на протяжении минимум одного месяца. Все пациенты основной группы были осмотрены до начала физической подготовки к оперативному лечению и после ее завершения. Тотальное эндопротезирование коленного сустава было выполнено всем 156 пациентам. Оценка объема движений в суставе производилась через 4 нед., 3, 6 и 12 мес. после оперативного вмешательства. Был определен срок, за который пациенты смогли достичь полного разгибания и сгибания до 90° в коленном суставе.

Результаты. Пациенты основной группы, выполнявшие физические упражнения в предоперационном периоде, смогли достичь сгибания в коленном суставе под углом 90° раньше (приблизительно 4 нед.), чем пациенты контрольной группы. Разница в сроках между сравниваемыми группами была статистически значимой (p<0,01). Разница в объеме движений в коленном суставе между пациентами обеих групп, отмеченная во время осмотров через 6 и 12 мес. после операции, была незначительной.

Заключение. Предреабилитация значительно улучшила показатели по шкале KSS у пациентов группы исследования как в предоперационном периоде, так и через 3 мес. после операции. Упражнения, выполняемые перед оперативным вмешательством, позволяют сократить сроки восстановления пациентов после ТЭКС и способствуют более быстрому достижению хороших функциональных результатов. Однако через год после операции статистически значимых различий в амплитуде сгибания и разгибания в коленных суставах у пациентов обеих группах отмечено не было.

Ключевые слова: остеоартроз коленного сустава, физические упражнения, функциональные результаты, тотальное эндопротезирование коленного сустава.

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INTRODUCTION

The most prevalent form of joint disease in the world, osteoarthritis (OA), has negative effects on musculoskeletal pain, disability, and socioeconomic expenses [1, 2, 3]. Osteoarthritis of the knee is associated with gradual decreases in strength, agility and reduced ability to perform daily chores [4, 5]. Initial medication is used to manage this condition, but it frequently worsens to the point that total knee arthroplasty (TKA) is the sole option for providing long-term pain relief [6]. Even while TKA surgery is excellent in relieving pain, it may still result in years of decreased leg strength [7, 8]. Older persons who have weak lower extremity muscles are more likely to fall and have decreased function [5]. People with knee OA show significantly reduced quadriceps strength relative to their unaffected leg or healthy age-matched controls [9, 10]. There has been mixed effectiveness with a variety of exercise regimens intended to increase leg strength and functional task performance in people prior to TKA [10, 11, 12].

Even with better surgical technique, postoperative physical therapy, and prosthetic design [13, 14], TKA rarely offers full range of motion (ROM) with flexion of more than 120. The majority of daily tasks can be comfortably carried out with a postoperative ROM of 100 to 120 [15]. Final flexion following TKA is affected by a number of factors, although preoperative range of motion is the most important [16, 17]. The chance that the accompanying stiffness of the extensor mechanism may lead to limited flexion following surgery increases with how restricted the preoperative range of motion was. It would make sense to enhance knee ROM before surgery in order to optimize flexion following TKA. A structured exercise programme intended to develop quadriceps and hamstring strength and endurance might cause even severely arthritic patients to respond within 4-6 weeks [18, 19]. Exercises can also improve balance and alleviate discomfort [20].

The aim of the study — to evaluate the functional performance and efficacy of the preoperative exercise programme on the osteoarthritic knee during the exercise period, during immediate postoperative recovery following arthroplasty, and at 1, 3, 6 and 12 months after surgery.

MATERIALS AND METHODS

Study design

The assessors in this prospective pilot randomized controlled research were blinded. Since participants had given informed consent to have joint arthroplasty, patient competence to consent was not explicitly assessed. The rights of the trial participants were maintained, and each patient gave written informed consent to take part.

One hundred fifty six non-inflammatory arthritis patients, aged 48 to 70, were enrolled in this prospective trial. They were randomly assigned to the treatment group or the control group.

Before TKA surgery, 78 patients (the treatment group) participated in a four-week home exercise regimen.

Prehabilitation exercises included resistance training, flexibility exercises, and quadriceps strengthening over the course of four weeks at home. The exercises were demonstrated to the patients, who had to perform them three times per day for four weeks.

Inclusion criteria

Non-inflammatory osteoarthritis with intentions for a primary unilateral TKA, moderate to severe pain in the afflicted knee, patient willing to volunteer to participate in the study by signing a consent form accepted by the ethical review committee, patient plans to be accessible for follow-up through 1 year postoperative, and good condition that allows safe participation in the preoperative home exercise programme were included.

Exclusion criteria

Patients with systemic inflammatory illness, or concurrent lower extremity abnormalities were excluded from the trial, as were patients who were unable to tolerate the preoperative and postoperative treatment programme. Patients were required to obtain an approval status from an internal medicine specialist, on which it should be noted that the patient has no medical conditions that would preclude them from undergoing surgery. BMI greater than 35, prior hip or knee replacement surgery, active local or systemic infection, high tibial osteotomy of the affected knee, flexion less than 80°, fixed flexion deformity greater than 20°, varus or valgus alignment greater than 10° unless correctable to under 10°, and most recently fractured upper or lower extremity were also excluded.

The patients who were included in the control group carried on as usual up until the procedure. During the baseline assessment, the treatment group's participants received individualized explanations of the exercises and completed one of them with the lead researcher. There was a regimen that was supposed to be followed at home for exercise.

The exercise plan was created to improve the soft tissues and muscle strength in the lower extremities. For four weeks, the subjects were required to complete the exercises at home. The exercises needed to be done without a physiotherapist's assistance.

The four-week therapy course was finished at the time of hospital admission the day before TKA

surgery. Just prior to surgery, participants in the treatment and control groups completed a second evaluation of knee range of motion and the KSS. Using a fixed bearing, cemented-retaining knee prosthesis while sacrificing the cruciate ligaments, a knee replacement procedure was carried out by anterior midline skin incision and medial parapatellar incision. All subjects underwent the same physiotherapy programme following surgery.

Outcome assessment

The time in days before reaching 90° of knee flexion and the length of the hospital stay were the data that were gathered. At 4 weeks, 3 months, 6 months, and 1 year, each subject had their knee ROM and KSS reevaluated.

The term «active knee flexion» refers to the maximum angle of knee flexion as measured using a goniometer when the patient is standing against a wall and the foot maintained parallel to the other leg. The passive knee flexion angle assessed with the patient resting supine on a table and knee flexion performed at the subject's muscle strength. In KSS the knee and patient function ratings are given distinct scores. Higher scores indicate greater knee and patient function.

Statistical analysis

Pearson's correlation was utilized as a bivariate measure. The Student t test was employed to compare variables throughout the statistical analysis, which was done using SPSS 20.0 (IBM® *SPSS*®). The statistical significance threshold was set at $p<0.05$.

RESULTS

One hundred fifty six participants were used in the study, equally split into two groups: those who participated in a prehabilitation programme (n = 78; 20 men and 58 females) and those who did not (n = 78; 25 males and 53 females). Patients ranged in age from 48 to 70 years.

Although there were statistically significant gains in knee and functional scores over time in both groups (with prehabilitation programme and without prehabilitation programme), there were no statistically significant changes in BMI over time ($p>0.05$). Both groups displayed comparable KSS levels (39.5 vs. 39.83) four weeks before surgery ($p = 0.8216$). The treatment group's KSS at baseline was 44.95, postoperative KS was 52.26, 1 month after surgery was 72.76, 3 months after surgery was 78.41, 6 months after surgery was 84.15, and after a year it was 86.77. The baseline KSS for the control group was 39.74, the postoperative KS was 47.15, the KSS at three months was 67.12, the KSS at six months was 83.05, and the KS at one year was 86.31.

After 4 weeks of training, the treatment group's passive and active flexion, extension, knee score, and patient function were significantly improved ($p< 0.001$). Patients in the treatment group achieved 90° of knee flexion on average 3.8 days (±1.2) following surgery, but patients in the control group did not achieve this milestone until 4.03 days (±1.5) following surgery. The treatment group's hospital stays were on average 4.1 days (±1.5) and the control groups were 5.5 days (±1.2) Exercise's impact on the knee score or patient function score, as determined by the KSS, was not supported by any data. When compared to the control group, the treatment group's extension range of motion was superior for the first 3 months, after which it remained the same in both research groups. With regular physiotherapy exercises, the range of motion advanced. After 4 weeks of rigorous physiotherapy, 12 patients with tight knees underwent manipulation under anesthesia. With time, the patient's knee and function scores improved, and they felt very at ease performing typical housekeeping tasks (Tab. 1, 2).

Figure 1 shows passive and active flexion and range of movements at different follow up.

Figure 2 shows graphical representation of KSS and patient function score at different follow-up.

Table 1

Knee scores for treatment and control group at different follow-up, mean (SD)

Group	Follow-up						
	4 weeks before surgery	Baseline	After surgery	1 m	3 m	6 m	12 m
Treatment	39.95 (3.195)	44.95 (3.195)	52.26 (1.607)	72.76 (7.838)	78.41 (5.241)	84.15 (5.643)	86.77 (3.486)
Control	39.83 (3.359)	39.74 (3.390)	47.15 (3.814)	67.12 (7.047)	75.32 (5.119)	83.05 (4.070)	86.31 (3.021)
p value	0.826	<0.001	<0.001	0.125	0.771	0.89	0.93

Table 2

Patient function scores for treatment and control group at different follow-up, mean (SD)

Group	Follow-up						
	4 weeks before surgery	Baseline	After surgery	1 m	3 m	6 m	12 m
Treatment	27.63 (5.625)	40.06 (3.558)	52.50 (5.568)	72.44 (2.414)	77.44 (2.463)	83.13 (2.486)	88.21 (2.503)
Control	27.24 (5.847)	27.56 (5.962)	47.69 (5.565)	68.31 (66.34)	76.99 (73.16)	82.12 (2.486)	87.24 (2.503)
p value	0.676	<0.001	<0.001	0.097	0.87	0.813	0.977

Fig. 1. Passive (a) and active (b) knee flexion for treatment and control groups at different follow-up

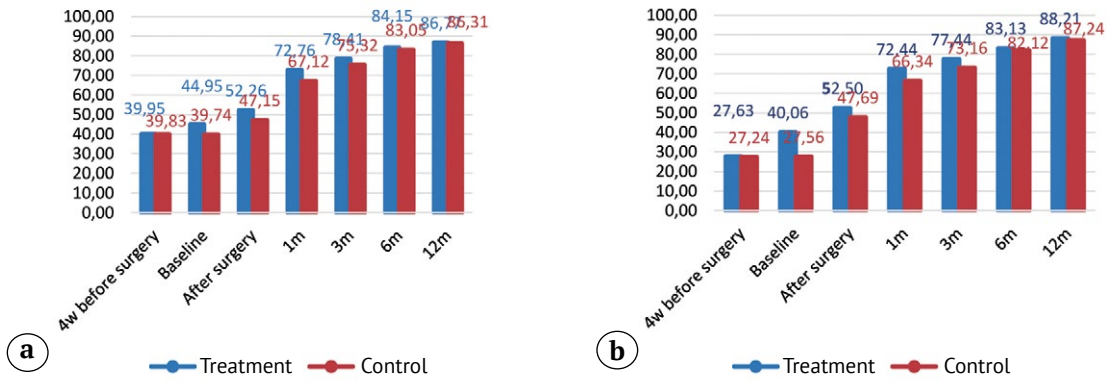

Fig. 2. Graphical representation of KSS (a) and patient function score (b) for treatment and control groups at different follow-up

DISCUSSION

In a randomized controlled experiment with 131 participants, L. Beaupre et al. published the findings of their preoperative exercise and education programme in 2004. Following the intervention programme or at any postoperative measurement point, there were no differences between the two groups in terms of knee measures (ROM and strength), pain, or function. Compared to the control group, patients in the treatment group required fewer postoperative rehabilitation services and were hospitalized for shorter periods of time, but these differences failed to reach statistical significance. Prior to surgery, patients in the treatment group participated in a four-week fitness and education programme. The aim of the exercise programme was to increase knee strength and mobility with straightforward exercises that were similar to those found in the postsurgical exercise programme. Exercises that build muscle and are isotonic were not added. This could be the cause of the stagnant increase in range of motion [21].

According to the results of his study, J.A. Rodgers found that physical therapy did not affect extension strength but did result in moderate increases in isokinetic flexion strength in these highly arthritic knees. Preoperative physical therapy had no impact on the postoperative decline in isokinetic strength. This study did not demonstrate any benefit from preoperative physical therapy before doing knee replacement surgery [22].

Prehabilitation improved the treatment group's leg strength and functional task performance as compared to the control group prior to TKA, according to the findings of A.M. Swank et al. Prehabilitation for a brief period of time (four to eight weeks) helped those with severe OA gain more strength and function [23].

The results of a study by C. McKay et al. showed that the intervention increased quadriceps strength, walking speed, and mental health prior to TKA in a way that was clinically significant. In the 12 weeks following surgery, it did not provide patients with any long-term benefits [24].

According to R. Topp et al. exercisers engaged in prehabilitation activities including resistance training and flexibility. The results appeared to corroborate the idea of prehabilitation and show the effectiveness of prehabilitation among TKA patients [25].

F. Matassi et al. also stressed that exercise programs improve knee motion in the presence of arthritis in their study, Range of motion following total knee arthroplasty: the influence of a preoperative home exercise programme. Exercises for the arthritic knee before surgery aid in the quick recovery after primary TKA [26].

The key result of the current study was that a preoperative home exercise regimen improves TKA recovery. The current study supports earlier findings that patients with degenerative knee problems can benefit from a balanced exercise regimen in terms of improved mobility and function.

CONCLUSION

Patients' mobility and function may benefit from an exercise regimen. Our research demonstrates a statistically significant difference between the treatment and control groups for KSS and patient function score. Following the prehabilitation therapy, KSS and patient function score increased. In conclusion, prehabilitation significantly improves the KSS for the intervention group both before surgery and three months after surgery. Exercises done before to surgery help patients recover more quickly from TKA and may speed up the process of achieving a good flexion and extension range of motion. It can help patients stretch their knees to 90° earlier. After one month of being out of the hospital and up to one year following surgery, there is no persistent postoperative effect.

DISCLAIMERS

Author contribution

Pavith Janardhan T. — conception and design of study; acquisition, analysis and interpretation of data.

Pothuri Rishi Ram — acquisition of data, drafting the manuscript.

Praveen Narayan — analysis and interpretation of data.

Surya Sri Karun Ch. — drafting the manuscript.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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Потури Риши Рам — сбор данных, написание текста статьи.

Правин Нараян — анализ и интерпретация данных.

Сурья Шри Карун Ч. — написание текста.

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REFERENCES

1. Calatayud J., Casaña J., Ezzatvar Y., Jakobsen M.D., Sundstrup E., Andersen L.L. High-intensity preoperative training improves physical and functional recovery in the early post-operative periods after total knee arthroplasty: a randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc*. 2017;25(9):2864-2872. doi: 10.1007/s00167-016-3985-5.
2. Allen K.D., Golightly Y.M. State of the evidence. *Curr Opin Rheumatol*. 2015;27(3):276-283. doi: 10.1097/BOR.0000000000000161.
3. Glyn-Jones S., Palmer A.J.R., Agricola R., Price A.J., Vincent T.L., Weinans H. et al. Osteoarthritis. *Lancet*. 2015; 386(9991):376-387. doi: 10.1016/S0140-6736(14)60802-3.
4. Creamer P. Current perspectives on the clinical presentation of joint pain in human OA. *Novartis Found Symp*. 2004;260:64-74; discussion 74-78, 100-104, 277-279.
5. Kamel H.K. Sarcopenia and aging. *Nutr Rev*. 2003;61 (5 Pt 1):157-67. doi: 10.1301/nr.2003.may.157-167.
6. Hawker G.A., Guan J., Croxford R., Coyte P.C., Glazier R.H., Harvey B.J. et al. A prospective population-based study of the predictors of undergoing total joint arthroplasty. *Arthritis Rheum*. 2006;54(10):3212-3220. doi: 10.1002/art.22146.
7. Hsu R.W., Tsai Y.H., Huang T.J. Hybrid total knee arthroplasty: A 3- to 6-year outcome analysis. *J Formos Med Assoc*. 1998;97(6):410-415.
8. Stevens J.E., Mizner R.L., Snyder-Mackler L. Quadriceps strength and volitional activation before and after total knee arthroplasty for osteoarthritis. *J Orthop Res*. 2003;21(5):775-779. doi: 10.1016/S0736-0266(03)00052-4.
9. Lewek M.D., Rudolph K.S., Snyder-Mackler L. Quadriceps femoris muscle weakness and activation failure in individuals with symptomatic knee osteoarthritis. *J Orthop Res*. 2004;22(1):110-115. doi: 10.1016/S0736-0266(03)00154-2.
10. Mizner R.L., Petterson S.C., Stevens J.E., Axe M.J., Snyder-Mackler L. Preoperative quadriceps strength predicts functional ability one year after total knee arthroplasty. *J Rheumatol*. 2005;32(8):1533-1539.
11. Beaupre L.A., Lier D., Davies D.M., Johnston D.B. The effect of a preoperative exercise and education program on functional recovery, health related quality of life, and health service utilization following primary total knee arthroplasty. *J Rheumatol*. 2004;31(6):1166-1173.
12. D'Lima D.D., Colwell C.W. Jr, Morris B.A., Hardwick M.E., Kozin F. The effect of preoperative exercise on total knee replacement outcomes. *Clin Orthop Relat Res*. 1996;(326):174-182. doi: 10.1097/00003086-199605000-00020
13. Akagi M., Nakamura T., Matsusue Y., Ueo T., Nishijyo K., Ohnishi E. The bisurface total knee replacement: a unique design for flexion: four-to-nine year follow-up study. *J Bone Joint Surg Am*. 2000;82(11):1626-1633. doi: 10.2106/00004623-200011000-00017.
14. Ranawat C.S. Design may be counterproductive for optimizing flexion after TKR. *Clin Orthop Relat Res*. 2003;(416):174-176. doi: 10.1097/01.blo.0000093028.56370.46.
15. Laubenthal K.N., Smidt G.L., Kettelkamp D.B. A quantitative analysis of knee motion during activities of daily living. *Phys Ther*. 1972;52(1):34-43. doi: 10.1093/ptj/52.1.34.
16. Parsley B.S., Engh G.A., Dwyer K.A. Preoperative flexion: does it influence postoperative flexion after posterior cruciateretaining total knee arthroplasty. *Clin Orthop Relat Res*. 1992;(275):204-210.
17. Ritter M.A., Harty L.D., Davis K.E., Meding J.B., Berend M.E. Predicting range of motion after total knee arthroplasty: clustering, log-linear regression and regression tree analysis. *J Bone Joint Surg Am*. 2003;85(7): 1278-1285. doi: 10.2106/00004623-200307000-00014.
18. Kovar P.A., Allegrante J.P., MacKenzie C.R., Peterson M.G., Gutin B., Charlson M.E. Supervised fitness walking in patients with osteoarthritis of the knee. A randomized, controlled trial. *Ann Intern Med*. 1992;116(7):529-534. doi: 10.7326/0003-4819-116-7-529.
19. Marks R. The effect of isometric quadriceps strength training in mid-range for osteoarthritis of the knee. *Arthritis Care Res*. 1993;6(1):52-56. doi: 10.1002/art.1790060110.
20. Ettinger W.H., Burns R., Messier S.P., Applegate W., Rejeski W.J., Morgan T. et al. A randomized trial comparing aerobic exercise and resistance exercise with a health education programme in older adults with knee osteoarthritis. The fitness arthritis and senior trial (FAST). *JAMA*. 1997;277(1):25-31.
21. Beaupre L., Davies D.M., Johnston D.B. The effect of a preoperative exercise and education program on functional recovery, health related quality of life, and health service utilization following primary TKA. *J Rheumatol*. 2004;31(6):1166-1173.
22. Rodgers J.A., Garvin K.L., Walker C.W., Morford D., Urban J., Bedard J. Preoperative physical therapy in primary TKA. *J Arthroplasty*. 1998;13(4):414-421. doi: 10.1016/s0883-5403(98)90007-9.
23. Swank A.M., Kachelman J.B., Bibeau W., Quesada P.M., Nyland J., Malkani A. et al. Prehabilitation before total knee arthroplasty increases strength and function in older adults with severe osteoarthritis. *J Strength Cond Res*. 2011;25(2):318-325. doi: 10.1519/JSC.0b013e318202e431.

24. McKay C., Prapavessis H., Doherty T. The effect of a prehabilitation exercise program on quadriceps strength for patients undergoing total knee arthroplasty: a randomized controlled pilot study. *PM R.* 2012;4(9):647-656. doi: 10.1016/j.pmrj.2012.04.012.
25. Topp R., Swank A.M., Quesada P.M., Nyland .J, Malkani A. The effect of prehabilitation exercise on strength and functioning after total knee arthroplasty. *PM R.* 2009;1(8):729-735. doi: 10.1016/j.pmrj.2009.06.003.
26. Matassi F., Duerinckx J., Vandenneucker H., Bellemans J. Range of motion after total knee arthroplasty: the effect of a preoperative home exercise program. *Knee Surg Sports Traumatol Arthrosc.* 2014;22(3):703-709. doi: 10.1007/s00167-012-2349-z.

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