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ORIGINAL ARTICLE

# Effects of a preoperative simplified home rehabilitation education program on length of stay of total knee arthroplasty patients

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## KEYWORDS

Total knee arthroplasty;  
Knee osteoarthritis;  
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**Summary** In patients with severe knee osteoarthritis (OA), total knee arthroplasty (TKA) is performed for both symptom relief and to achieve better function in daily life. Implementation of efficient TKA rehabilitation programs with shorter length of stay (LOS) and reduced medical expenditures is an important issue in clinical practice. However, the effectiveness of preoperative rehabilitation programs is still under debate. Most preoperative rehabilitation programs last many weeks and may be more expensive than TKA. The purpose of this study was to investigate the effects of a simplified, easy-to-learn, and less time-consuming preoperative rehabilitation education program on TKA patients.

**Patients and methods:** In this randomized controlled study, we allocated all the patients into study and control group according to chart number. The study group, which comprised 126 patients, participated in a 40-min preoperative home rehabilitation education program 4 weeks prior to TKA. One hundred seventeen patients in the control group did not participate in this preoperative program.

**Results:** The study group required a shorter hospital LOS (mean: 7.12 days;  $P=0.027$ ) and had less hospitalization-related medical expenditures (mean: 123726 New Taiwan dollars [NTD], equivalent to 4266.4 United States dollars [USD] or 3022.1 [Euros]), ( $P=0.001$ ) than the control group. However, the study group showed no significant improvement in function when compared to the control group.

**Discussion:** Our study demonstrates that a simplified preoperative rehabilitation program can reduce LOS and increase cost savings. This program was recommended as a routine protocol for OA patients before admission for TKA.

**Level of evidence:** Level II. Prospective randomized study.

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## Introduction

Osteoarthritis (OA) of the knee, the most frequently affected joint, is a leading cause of disability and functional limitations in adults [1,2]. Total knee arthroplasty (TKA) is the most commonly recommended intervention [3,4].

Exercise is a cornerstone of effective rehabilitation programs after total joint arthroplasty and other surgical procedures [5]. However, in addition to postoperative rehabilitation, preoperative rehabilitation could be also implicated as a potentially beneficial procedure in preparation for surgery. A previous study showed that preoperative optimization of functional ability in knee OA patients could improve the functional ability and decrease length of stay (LOS) after TKA [6]. In addition, range of motion (ROM), strength, and pain in the knee before operation have been noted to be predictive factors for post-TKA pain, ROM, and functional restoration [7]. However, the effects of preoperative exercise programs on post-TKA functional restoration are still under investigation. For example, Rook et al. reported that a 6-week preoperative exercise program improved muscle strength and functional ability, thereby reducing the LOS following TKA [8]. In contrast, other studies have reported no significant effects of pre-TKA exercise programs on post-TKA functional ability and strength. [9,10]. Moreover, the problems of cost and time investment required in these interventions were not addressed. Thus, additional studies are warranted to determine whether an efficient pre-TKA home rehabilitation and education program can be implemented.

The purpose of this study was to investigate the effects of a simplified preoperative rehabilitation and education program intervention on knee pain, ROM, and LOS among patients who were admitted to undergo TKA. We hypothesized that OA patients participating in this preoperative program would experience improved ROM of

the knee, reduced pain, and decreased hospital LOS for TKA.

## Methods

### Participants

Eligible participants were scheduled to undergo unilateral, primary TKA for advanced OA. Additional eligibility criteria included the ability to follow our rehabilitation program and an interval of 4 weeks between enrolment and time until surgery to permit sufficient time for the intervention. From 2008 to 2010, eligible patients from our orthopedic department were scheduled to undergo TKA at a tertiary medical center in central Taiwan. Patients with inflammatory arthritis (e.g., rheumatoid arthritis or psoriatic arthritis) or any medical condition in which a moderate level of exercise was contraindicated (e.g., heart failure or hypertension) were not enrolled. Patients were also not eligible if they were scheduled to have bilateral joint replacements. This study was performed according to ethical guidelines approved by the institutional review board in our hospital.

### Design

Fig. 1 shows the flow diagram of the study. Of the 276 patients screened, 243 were determined to be eligible. Among these, 126 patients were assigned to the study group, and 117 were assigned to the control group. For this randomized controlled study, participants were randomly allocated to either the study or control group by chart number while their TKA was being scheduled in the orthopedic outpatient department (OPD). Subjects assigned to the study group immediately participated in the 4-week home rehabilitation education program after baseline measurements were taken.

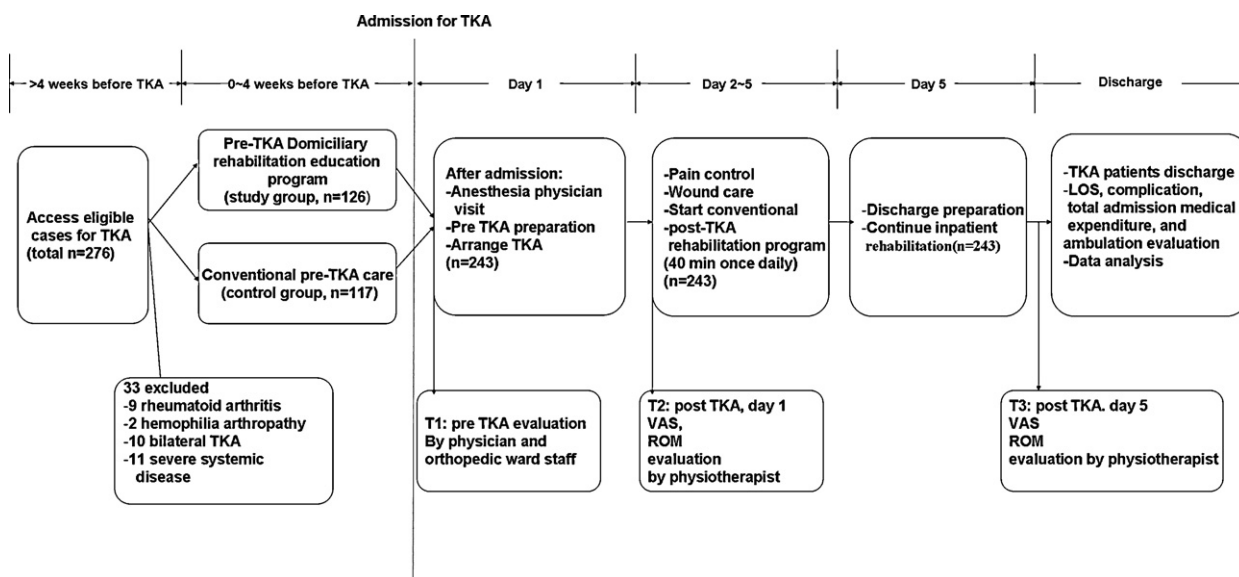


Figure 1 Study flow chart.

## Conventional group

After patients were scheduled for TKA in the orthopedic OPD, routine examinations including knee X-ray radiography, electrocardiography, and blood cell counts were arranged before admission for TKA. During the time between enrollment in the study and hospitalization for TKA, usual leisure activities and exercises were not prohibited. At the time of surgery, all the participants participated in a standard rehabilitation program once a day for 40 min. The structure of this program was dependent on the patient's post-TKA functional status, which was determined by evaluations conducted by our physiotherapist.

## Study group (the preoperative simplified rehabilitation education group)

Participants in the study group, in addition to following the protocol of the control group, also engaged in a preoperative rehabilitation education program beginning 2 to 4 weeks prior to admission. Patients were referred to our physical medicine and rehabilitation department for preoperative program education. The program was taught by an experienced physiotherapist during a 40-min meeting in our clinic. We simplified the rehabilitation protocol in order to achieve better adherence by participants at home and to reduce the associated economic burden. The focus of this home exercise program was thigh muscle strength training. Exercises included straight leg raising, knee setting, ankle pumping, and hip abduction with resistance. The educational content provided to each patient included information on the following aspects: the protocol for the TKA hospitalization and discharge program, post-TKA rehabilitation program, safe transferring technique, device-using guide for crutches and canes, and fall prevention information. All the content was designed as an educational booklet and provided to the study group after this educational session by our therapist. One week prior to admission, participants in the study group received a telephone call from our physiotherapist in order to get answers for any questions they might have about the home rehabilitation program or the educational booklet.

## Outcome measures

In order to analyze the effects of this simplified program on hospitalization, we assessed the functional recovery, pain

tolerance, medical cost, LOS, and post-TKA complication rate for participants in this study. Patients were asked to evaluate their knee pain during and after activities by using a visual analog scale (VAS). [11,12]. Functional recovery was simplified to include knee ROM and ambulation status. These parameters were determined by two physical therapists, each with more than 5 years of experience and knee ROM was measured following the methods described by Brosseau [13]. VAS and ROM data were collected at three assessment time points: pre-TKA, post-TKA, and on the discharge day of hospitalization following TKA for comparison. Medical cost was calculated as the total medical expenditure of hospitalization for TKA, including preoperative care, prosthesis, operation, and post-TKA costs. All costs were measured in NTD (1 EUR is equal to 41 NTD). Patient can be discharged when meet the discharge criteria: knee flexion ROM above 90 degrees; can ambulate independently for more than 15 meters. Both LOS and medical costs were obtained from the medical information system in our hospital. Information regarding post-TKA complication prevalence was collected during the entire acute inpatient period in both groups.

## Statistics

Continuous variables were analyzed by Student *t* test for inter-group comparisons. Pearson's Chi<sup>2</sup> test was applied to compare categorical variables between the study and control groups. Data are presented as means or percentages with standard deviations indicated. SPSS 17.0 software was used for all statistical analyses, and *P* values less than 0.05 were considered statistically significant.

## Results

A total of 273 patients participated in this randomized controlled study from 2008–2010. The mean age of the subjects was 70 ± 7 years, and 71.6% of the patients were women.

No preoperative differences were noted between the two groups (Table 1). Hospital LOS was 7 ± 2 (range from 5 to 10) days for the study group and 8 ± 1 (range from 5 to 12) days for the control group (CI: -0.795 to -0.044; *P* = 0.027). The average hospitalization-associated medical expenditure for the study group (123726 ± 5204 NTD) was significantly lower than that for the control group (125838 ± 4428 NTD, CI: -3336 to -885; *P* = 0.001). We observed no difference

**Table 1** Demographic data of this study.

Variables (mean ± SD)	Total (n = 243)	Study group (n = 126)	Control group (n = 117)	<i>P</i> value
Age (years)	70.2 ± 7.3	69.8 ± 7.2	70.5 ± 7.4	0.454
Body weight (kg)	65.2 ± 10.7	64.9 ± 9.3	65.6 ± 12.1	0.639
Body height (cm)	155.0 ± 7.5	154.8 ± 7.0	155.1 ± 8.0	0.757
BMI (kg/m <sup>2</sup> )	27.2 ± 4.2	27.1 ± 4.0	27.2 ± 4.5	0.909
Gender (female, %)	71.6	69.8	73.5	0.527 <sup>a</sup>
Alback	3.04 ± 0.82	2.98 ± 0.80	3.09 ± 0.83	0.294
Barthel index	67.3 ± 15.1	67.1 ± 15.9	67.4 ± 14.2	0.864
ASA	2.56 ± 0.50	2.58 ± 0.50	2.54 ± 0.50	0.523

<sup>a</sup> Pearson's Chi<sup>2</sup> test.

**Table 2** Outcome comparison of both groups.

Variables (mean $\pm$ SD)	Total (n = 243)	Study group (n = 126)	Control group (n = 117)	P value
LOS	7 $\pm$ 2	7 $\pm$ 2	8 $\pm$ 1	0.027 <sup>a</sup>
Medical cost (1000NTD)	124.7 $\pm$ 5.0	123.7 $\pm$ 5.2	125.8 $\pm$ 4.4	0.001 <sup>a</sup>
Fall in Hb, g/dL	2.4 $\pm$ 0.5	2.4 $\pm$ 0.4	2.4 $\pm$ 0.5	0.831 <sup>a</sup>
Blood transfusion, %	10.3	11.9	8.5	0.389 <sup>b</sup>
Infection, %	1.2	1.6	0.9	0.605 <sup>b</sup>
DVT, %	3.3	4.0	2.6	0.514 <sup>b</sup>
Ambulation <sup>c</sup> , %	83.5	85.7	81.2	0.343 <sup>b</sup>

<sup>a</sup>  $P < 0.05$ , independent  $t$  test.

<sup>b</sup> Pearson's  $\chi^2$  test.

<sup>c</sup> Ambulation status was evaluated on day 5 post-TKA.

**Table 3** Comparison range of motion (ROM) and visual analog scale (VAS) of both groups at different time point.

Variables (mean $\pm$ SD)	Total (n = 243)	Study group (n = 126)	Control group (n = 117)	P value
<i>Knee ROM</i>				
T1	91 $\pm$ 7	92 $\pm$ 7	91 $\pm$ 7	0.549
T2	30 $\pm$ 12	30 $\pm$ 11	30 $\pm$ 12	0.673
T3	75 $\pm$ 22	76 $\pm$ 22	74 $\pm$ 20	0.582
<i>VAS (0–10)</i>				
T1	6.4 $\pm$ 1.0	6.4 $\pm$ 1.0	6.5 $\pm$ 1.0	0.362
T2	4.4 $\pm$ 1.2	4.5 $\pm$ 1.3	4.4 $\pm$ 1.2	0.431
T3	2.4 $\pm$ 0.6	2.4 $\pm$ 0.7	2.5 $\pm$ 0.6	0.686

T1: before receiving TKA when admission; T2: day 1 post-TKA; T3: day 5 post-TKA.

between the two groups in terms of the patients' ability to walk when evaluated on day 5 after admission. The prevalence of postoperative complications after surgery and blood loss during TKA was similar in both groups (Table 2). When comparing the VAS and knee ROM of the study group versus the control group, we failed to observe a significant improvement during hospitalization (Table 3).

## Discussion

Our study shows that a preoperative home rehabilitation education program can reduce hospital LOS and the medical expenditure required for TKA hospitalization. Our study focuses only on patients who were admitted for unilateral TKA and who had not previously undergone TKA. Previous studies have mentioned that certain factors may prolong LOS of TKA patients. For example: increased age, female gender, and comorbidity status are associated with a longer LOS [14,15]. These factors did not influence our study.

In our country, most patients' knowledge of TKA could be attributed to the media and to experiences of family or friends. These routes may provide inadequate information to patients and may lead them to have unrealistic expectations regarding postoperative pain relief and functional restoration [16,17]. Therefore, an appropriate preoperative rehabilitation education program consisting of preoperative home exercise, post-TKA rehabilitation, information on safe transferring technique, and ambulatory device usage may help patients better prepare for the post-TKA functional restoration program administered during hospitalization

[18]. Our study results are in contrast to a previous study, where a preoperative patient education does not reduce the LOS after large joint replacement [19]. This previous study may indicate that merely educational information providing is not enough for the intention for reduce LOS. Therefore, in addition to providing patients with the educational program in both verbal and written formats, our physiotherapist also taught home rehabilitation and post-TKA transferring technique to participants in the study group.

With respect to reducing medical expenditure, controlling the hospital LOS has become an important factor in determining the overall cost of patient care [20]. Both groups in this study underwent the same clinical pathway intervention. Patients interacted with the same interdisciplinary team during the course of TKA admission. We observe no difference between the two groups with respect to the percentage of postoperative complications or blood transfusion. We expect that the reduction in medical expenditures seen in the study group is the result of decreased LOS. However, pre-admission medical expenditure, including costs of outpatient medication, educational booklets, and the preoperative home rehabilitation education program, are not included in this study. Both groups accept the same preoperative program (same outpatient medication, educational booklets) except the study group has additional simplified preoperative program which costs 360NTD.

Knee flexion ROM is often used as one of the outcome measure of TKA [21]. Our study shows that a preoperative home rehabilitation program has no significant effect on knee flexion ROM following TKA. This result is similar to the findings of a previous study [9]. They propose 12

preoperative rehabilitation and education programs, each lasting 1.5 h, in a community rehabilitation clinic. They find no statistical differences in activities of daily living (ADL), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), knee ROM, or strength.

Our study indicates that participation in a preoperative rehabilitation education program provides no significant pain relief following acute inpatient hospitalization post-TKA. In a previous study in which the patient used the VAS for self-reported pain assessment, the intensity of pain experienced 3 months following TKA was often half of that experienced preoperatively [22]. In accordance with a previous study investigating the effects of preoperative exercise on TKA and TKR patients, we find that the SF-36 and WOMAC pain scores are not significantly improved within 8 weeks after the operation [9]. However, better SF-36 pain scores are observed in the study group at 26 weeks after operation. Certain preoperative factors have been shown to predict pain during the early period following TKA. Roth et al. demonstrate that a negative mood is positively and consistently correlated to pain and emerges as a strong predictor of pain on day 3 after TKA. Furthermore, in their study, they find that catastrophizing is an effective predictor of pain on day 2 after the operation [23]. With respect to the potential benefits that education can have on negative mood, a previous study shows that preoperative information can lessen anxiety and pain on the first 3 days following operation [24]. Our study principally involves participation in a preoperative home rehabilitation program for 4 to 6 weeks. Positive mood and supportive education are not emphasized in the protocol applied to the study group. This may account for the lack of increased pain relief experienced by the study group during the inpatient period despite a reduced LOS.

Our study demonstrates no difference between the study and control groups in terms of the outcome measurements of complication rates following TKA. A previous study concluded that age, BMI, and cerebrovascular disease are predictors of post-TKA complications [25]. In our study of the preoperative home rehabilitation and education program, these predictors do not influence the outcome.

Our study has a few limitations. First, the cost of the preoperative education and rehabilitation program is not evaluated. We estimate the cost of physiotherapist consultation in this simplified program to be about 360NTD (9EUR). This is minimal and only accounts for 0.3% of the total cost of TKA hospitalization. In contrast, the average cost savings in the study group is about 2000NTD. Our program still results in reduced medical expenditure. Second, muscle strength and ADL evaluation are not performed in this study. Previous studies on the effectiveness of preoperative rehabilitation programs indicate that muscle strength and ADL are not significantly improved until 4 weeks post-TKA [26]. We did not address this, since our study only focuses on the effects of the preoperative program during the acute inpatient phase.

In conclusion, implementation of this simplified preoperative education and home rehabilitation program can reduce medical expenditure and hospital LOS for the acute inpatient phase in first-time TKA patients. This outcome may not be due to better function restoration and pain relief. We expect that our program prepares patients better for the post-TKA phase. Further studies are needed in order to

investigate the long-term effects of this program and evaluate this TKA rehabilitation regimen.

## Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

## Appendix A.

The protocol of preoperative simplified home rehabilitation and education program.

**Straight leg raising exercise:** patient is in a supine posture and raises the leg about 45 to 60 degrees from the bed, holding the leg in this position for 3 to 5 s.

**Knee setting:** patient is in the supine posture and compressing the towel, which is placed below the knee, for 3 to 5 s.

**Ankle pumping:** a simple exercise for better circulation of leg and ankle, where the patient holds dorsiflexion and plantar flexion for 3 to 5 s separately.

**Hip abduction:** patient is in the supine posture with hip abduction to 45 degrees and holds this position for 10 s before returning to the neutral position.

Three sets of 20 repetitions for each resistance activity were suggested at home.

## References

- [1] Peat G, McCarney R, Croft P. Knee pain and osteoarthritis in older adults: a review of community burden and current use of primary health care. *Ann Rheum Dis* 2001;60:91–7.
- [2] Dunlop DD, Manheim LM, Song J, Chang RW. Arthritis prevalence and activity limitations in older adults. *Arthritis Rheum* 2001;44:212–21.
- [3] Jones CA, Voaklander DC, Johnston DW, Suarez-Almazor ME. Health related quality of life outcomes after total hip and knee arthroplasties in a community based population. *J Rheumatol* 2000;27:1745–52.
- [4] Hawker G, Wright J, Coyte P, et al. Health related quality of life after knee replacement. *J Bone Joint Surg Am* 1998;80:163–73.
- [5] Kuster MS. Exercise recommendations after total joint replacement: a review of the current literature and proposal of scientifically based guidelines. *Sports Med* 2002;32:433–45.
- [6] Dennis DA, Komistek RD, Scuderi GR, Zingde S. Factors affecting flexion after total knee arthroplasty. *Clin Orthop Relat Res* 2007;464:53–60.
- [7] Escalante A, Beardmore TD. Predicting length of stay after hip or knee replacement for rheumatoid arthritis. *J Rheumatol* 1997;24:146–52.
- [8] Rooks DS, Huang J, Bierbaum BE, et al. Effect of preoperative exercise on measures of functional status in men and women undergoing total hip and knee arthroplasty. *Arthritis Rheum* 2006;55:700–8.
- [9] Beaupre LA, Lier D, Davies DM, Johnston DB. 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;31:1166–73.
- [10] Rodgers JA, Garvin KL, Walker CW, Morford D, Urban J, Bedard J. Preoperative physical therapy in primary total knee arthroplasty. *J Arthroplasty* 1998;13:414–21.



- [11] Carlsson AM. Assessment of chronic pain, I: aspects of the reliability and validity of the visual analogue scale. *Pain* 1983;16:87–101.
- [12] Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. *Pain* 1983;17:45–56.
- [13] Brosseau L, Balmer S, Tousignant M, et al. Intra- and intertester reliability and criterion validity of the parallelogram and universal goniometers for measuring maximum active knee flexion and extension of patients with knee restrictions. *Arch Phys Med Rehabil* 2001;82:396–402.
- [14] Jones CA, Voaklander DC, Johnston DW, et al. The effect of age on pain, function, and quality of life after total hip and knee arthroplasty. *Arch Intern Med* 2001;161:454–60.
- [15] Katz JN, Wright EA, Guadagnoli E, et al. Differences between men and women under going major orthopedic surgery for degenerative arthritis. *Arthritis Rheum* 1994;37:687–94.
- [16] Aarons H, Forester A, Hall G, Salmon P. Fatigue after major joint arthroplasty: relationship to preoperative fatigue and postoperative emotional state. *J Psychosom Res* 1996;41:225–33.
- [17] Aarons H, Hall G, Hughes S, Salmon P. Short-term recovery from hip and knee arthroplasty. *J Bone Joint Surg Br* 1996;78:555–8.
- [18] Gammon J, Mulholland CW. Effect of preparatory information prior to elective total hip replacement on postoperative physical coping outcomes. *Int J Nurs Stud* 1996;33:589–604.
- [19] Husted H, Holm G, Jacobsen S. Predictors of length of stay and patient satisfaction after hip and knee replacement surgery fast-track experience in 712 patients. *Acta Orthop* 2008;79:168–73.
- [20] Healy WL, Iorio R, Ko J, Appleby D, Lemos DW. Impact of cost reduction programs on short-term patient outcome and hospital cost of total knee arthroplasty. *J Bone Joint Surg Am* 2002;84:348–53.
- [21] Denis M, Moffet H, Caron F, Ouellet D, Paquet J, Nolet L. Effectiveness of continuous passive motion and conventional physical therapy after total knee arthroplasty: a randomized clinical trial. *Phys Ther* 2006;86:174–85.
- [22] Brander VA, Stulberg SD, Adams AD, et al. Predicting total knee replacement pain: a prospective, observational study. *Clin Orthop Relat Res* 2003;416:27–36.
- [23] Roth ML, Tripp DA, Harrison MH, Sullivan M, Carson P. Demographic and psychosocial predictors of acute perioperative pain for total knee arthroplasty. *Pain Res Manag* 2007;12:185–94.
- [24] Sjöling M, Nordahl G, Olofsson N, Asplund K. The impact of preoperative information on state anxiety, postoperative pain and satisfaction with pain management. *Patient Educ Couns* 2003;51:169–76.
- [25] Yasunaga H, Tsuchiya K, Matsuyama Y, Ohe K. Analysis of factors affecting operating time, postoperative complications, and length of stay for total knee arthroplasty: nationwide web-based survey. *J Orthop Sci* 2009;14:10–6.
- [26] Topp R, Swank AM, Quesada PM, Nyland J, Malkani A. The effect of prehabilitation exercise on strength and functioning after total knee arthroplasty. *PMR* 2009;1:729–35.