Original Article

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Assessment of Postoperative Rehabilitation Outcome after Total Knee Replacement with WOMAC Score

Pei-Chi Wu[1,3,†], Chia-Chen Lin[1,†], Chieh-Yi Hou[2,3,], Jih-Hsi Yeh[1], Li-Jen Yuan[1], Chia-Jen Hsu[1], Tzu-Ying Liu[1], Lei-Yi Wang[1], Min-Hua Lee[1], Lian-En Huang[1]*

Objective: Although total knee replacement (TKR) techniques and implants are well-developed and the outcomes are usually satisfactory patient-centered care for patients undergoing TKR is still challenging. We aimed at identifying the favorable prognostic factors after physical rehabilitation in patients following TKR.

Methods: A total of 158 patients undergoing TKR were assessed with the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). The parameters for analysis after post-TKR and rehabilitation included sex, age, body-mass index (BMI), site of operation, education, occupation, and prosthesis used. Scoring was evaluated preoperatively and at postoperative three months. Preoperative design of a rehabilitation exercise program enabled immediate postsurgical physical training. Participation in components of the rehabilitation exercise program was encouraged during both the hospital stay and at home.

Results: The pain, dysfunction, and stiffness scores significantly decreased in patients who experienced improvements after TKR ($p < 0.001$). The total score decreased to 8.1 ± 4.9 from 55.8 ± 10.4 ($p < 0.001$) after the operation. The scores of all variates, except the prosthesis and site of knee, decreased by over 80%. Pain and function scores did not worsen after the operation. Significant differences, in terms of the odds ratio for WOMAC scores that decreased by over 80%, were observed for the variables of age, BMI, education, and occupation for pain scores, and for site of knee for function scores. The ratio to reach a decreased score was lower for those aged ≥ 80 years or those with BMI above 24.1. The improvement in stiffness was relatively unsatisfactory and stiffness worsened in eight patients after TKR.

Conclusions: Postoperative exercise is strongly encouraged, and is expected to be more effective after TKR. Improvement after TKR was satisfactory and early rehabilitation is encouraged, regardless of prognostic factors.

Key words: osteoarthritis, total knee replacement, outcome, WOMAC score

From the [1]Department of Physical Medicine and Rehabilitation, E-Da Hospital; [2]Department of Physical Medicine and Rehabilitation, E-Da Cancer Hospital; [3]Department of Physical Therapy, I-Shou University, Kaohsiung, Taiwan.
(† signifies equal contribution compared to the first author)
Received: December 22, 2020 Accepted: March 18, 2021
* Address reprint request and correspondence to: Chieh-Yi Hou, Department of Physical Medicine and Rehabilitation, E-Da Cancer Hospital, No.21, Yida Road, Jiaosu Village, Yanchao District, Kaohsiung City 82445, Taiwan.
Tel: +886-7-615-0011 ext. 2340, E-mail: ed100699@edah.org.tw

Introduction

The population of Taiwan is rapidly aging, with 14.2% of the population over 65 years old in 2018,[1] highlighting an increasing need for long-term care including programs for preventing and delaying age-related physical and cognitive disabilities. Disability of the knee joint due to degenerative osteoarthritis (OA), which limits movement in daily life and is a major issue for the elderly,[2,3] is a common indication for total knee replacement (TKR) in the elderly.[4,5] Previous studied reported considerable post-TKR improvements in joint pain, walking ability, and quality of life that could persist for years.[5,6] However, since chronic joint diseases that have existed for decades before surgery do not spontaneously resolve after TKR,[7,8] some functional limitations persist after TKR. Although intensive exercise programs could overcome such limitations, they are not well-tolerated by many patients until at least two months after surgery.[7,9] Exercise therapy could be a simple solution to persistent mobility limitations for enhancing TKR outcomes.[9]

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is commonly used to assess patients with OA of the hip or knee, using 24 parameters including pain, stiffness, and physical function subscales.[10] WOMAC is a disease-specific and purpose-oriented tool for evaluative research in OA clinical trials. It can be used to monitor the course of the disease or determine the effectiveness of medical or surgical therapy. The index also assesses patients' daily physical, social, and emotional functions.

TKR is a common surgical procedure for relieving pain and disability caused by arthritis, most commonly OA. Generally, the surgery consists of replacing diseased or damaged joint surfaces of the knee with metal and plastic components designed to allow continued motion of the knee. Although the techniques and implants of TKR are well-developed with generally satisfactory outcomes, providing standardized and patient-centered care remains a challenge to clinicians. Hence, we aimed at identifying the favorable prognostic factors after physical rehabilitation among patients undergoing TKR.

Materials and Methods

A total of 158 patients (34 [24.5%] males and 124 [75.5%] females) underwent TKR at ourhospital in 2019. The study parameters included sex, age, body mass index (BMI), site of operation, education, occupation, and prosthesis used. Adult patients (> 18 years old) who have been diagnosed by a physician as having arthritis of the knee (OA, rheumatic arthritis, or post-traumatic arthritis) undergoing TKR treatment were eligible for the current study. The exclusion criteria were multiple comorbidities such as poorly controlled diabetes (HbA1c > 7.0), ongoing infection (e.g., symptomatic urinary tract infection), history of previous osteomyelitis and/or deep knee infection, and revision surgeries. Patients who were unwilling to join, those failed to follow instructions given by the staff, and those with physical conditions including incidental diagnosis of cancer, coronary artery disease, pneumonia, or stroke as well as those required a change in orthopedic treatment protocol were also excluded. After discharge from the hospital, all patients were given instructions on self-exercise by a designated case coordinator as a standard treatment protocol after TKR.

The WOMAC is the sum of the subscores on 24 questions, the answer to each of which was given a score from 0 to 4 based on a five-point Likert scale (none, mild, moderate, severe, and extreme, respectively).[10] The index can be reported as a total score or separately on three subscales that assess pain, physical function, and stiffness. The numbers of ques-

tions for the pain, physical function, and stiffness subscales were 5, 17, and 2, respectively, giving a total score ranging from 0 to 96. The scoring was evaluated preoperatively and at postoperative three months. and education on self-exercise was given by the case manager according to the program of our hospital.

Preoperative consultation with a rehabilitation physician to design a suitable postoperative rehabilitation program allowed immediate implementation of physical training after surgery. Rehabilitation participatory exercise components may encourage regular exercise more effectively under the program for TKR patients during their hospital stay or at home. The commencement of rehabilitation on the operative day improves patient outcomes and decreases the duration of stay and pain. Protected weight bearing using crutches or a walker is required until the quadriceps muscle heals and recovers its strength. Continuous passive motion is commonly used postoperatively for range-of-motion exercises. In our study, we checked the pain score regularly before and after each rehabilitation program and provided adequate medications according to the patients' conditions for better pain control. This can improve the effectiveness and satisfaction of rehabilitation. All patients received a detailed education on pain management after hospital admission. Patients were encouraged to request adequate pain control after the procedure. The case manager followed up on the patients by telephone at three days, two weeks, one month, and three months after discharge. The first follow-up involved the orthopedic and rehabilitation departments at the outpatient ward one week after discharge. The conditions of the patients were comprehensively evaluated during each appointment at the outpatient ward, including assessment of wound healing, mental status, range of motion, walking ability, and pain score. The standardized transdisciplinary model was applied to improve rehabilitation quality after TKR surgery. The test procedures in this study were reviewed and approved by the Human Test Ethics Committee of E-Da Hospital (Case No. EMRP-109-149).

The independent *t*-test, χ^2 test, ANOVA, and logistic regression were performed using a statistical software program (SPSS, version 25.0; IBM Institute Inc.). *P*-values less than 0.05 were regarded as significant.

Results

The reduction in WOMAC scores clearly indicate postoperative improvements in pain, physical function, and stiffness (Table 1). The scores for each category significantly decreased ($p < 0.001$) for all variates, indicating considerable patient improvement. The total score decreased to 8.1 ± 4.9 from 55.8 ± 10.4 ($p < 0.001$) after the operation. Those who experienced changes in their functional performance were also more likely to have a reduced WOMAC score.

For scores that decreased by over 80% (postoperative/preoperative scores), significant differences were not noted for any of the variables under investigation, except for the type of prosthesis and the site of knee (Table 2). The pain score decreased by over 80% in 110 (85.9%) of the 128 patients whose prosthesis was covered by national insurance, and in all 30 patients who self-paid for more advanced prostheses ($p < 0.025$), as shown in Table 2. For physical function, the score decreased by over 80% in 63 of 92 patients (76.8%) in the right knee, and 70 of 76 patients (92.1%) in the left knee ($p < 0.009$). No patient experienced worse pain and function after the operation, but some did experience worse stiffness.

General improvement in terms of the odds ratio for an over 80% reduction in the WOMAC score varied significantly with age, BMI, education, and occupation in the pain category, and site of knee under the function category (Table 3). The odds ratio of obtaining a lower score was lesser for those aged

Table 1. WOMAC scores before and after TKR operation for each variate.

Parameter	Pain score			Function score			Stiffness score			WOMAC score		
	Pre-op	Post-op	*p*	Pre-op	Post-op	*p*	Pre-op	Post-op	*p*	Pre-op	Post-op	*p*
Total (N = 158)	12.1 ± 3.0	1.1 ± 1.4	< 0.001*	39.0 ± 7.5	5.8 ± 4.4	< 0.001*	4.7 ± 1.8	1.3 ± 1.0	< 0.001*	55.8 ± 10.4	8.1 ± 4.9	< 0.001*
Gender												
male (n = 34)	11.2 ± 3.2	0.9 ± 1.2	< 0.001*	39.1 ± 7.6	5.9 ± 3.3	< 0.001*	4.6 ± 1.9	1.4 ± 1.4	< 0.001*	54.9 ± 10.6	8.2 ± 3.9	< 0.001*
female (n = 124)	12.3 ± 2.9	1.1 ± 1.4	< 0.001*	39.0 ± 7.5	5.8 ± 4.7	< 0.001*	4.7 ± 1.8	1.2 ± 0.8	< 0.001*	56.0 ± 10.3	8.0 ± 5.2	< 0.001*
Age												
≤ 64 (n = 33)	12.5 ± 3.8	0.7 ± 1.2	< 0.001*	39.2 ± 8.0	5.1 ± 3.0	< 0.001*	4.4 ± 2.2	1.2 ± 1.3	< 0.001*	56.1 ± 11.6	6.9 ± 3.4	< 0.001*
65 – 79 (n = 95)	11.8 ± 2.8	1.2 ± 1.5	< 0.001*	38.2 ± 6.7	5.6 ± 4.9	< 0.001*	4.7 ± 1.7	1.3 ± 0.9	< 0.001*	54.7 ± 9.3	8.0 ± 5.5	< 0.001*
80 (n = 30)	12.4 ± 2.8	1.1 ± 1.0	< 0.001*	41.4 ± 9.1	7.4 ± 3.7	< 0.001*	5.1 ± 1.8	1.4 ± 0.7	< 0.001*	58.8 ± 11.8	9.5 ± 4.2	< 0.001*
BMI												
≤ 18.5 (n = 0)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
18.6 – 24 (n = 36)	12.4 ± 3.1	0.8 ± 1.2	< 0.001*	38.7 ± 7.3	6.3 ± 7.3	< 0.001*	4.9 ± 1.5	1.2 ± 0.8	< 0.001*	56.0 ± 10.3	8.0 ± 7.3	< 0.001*
≥ 24.1 (n = 122)	12.0 ± 3.0	1.1 ± 1.4	< 0.001*	39.1 ± 7.6	5.7 ± 3.1	< 0.001*	4.6 ± 1.9	1.3 ± 1.0	< 0.001*	55.7 ± 10.4	8.3 ± 7.3	< 0.001*
Knee location												
right (n = 82)	11.9 ± 2.8	0.9 ± 1.2	< 0.001*	39.4 ± 7.0	6.3 ± 5.4	< 0.001*	4.7 ± 1.9	1.3 ± 0.9	< 0.001*	56.0 ± 9.5	8.3 ± 5.6	< 0.001*
left (n = 76)	12.2 ± 3.2	1.3 ± 1.5	< 0.001*	38.6 ± 8.1	5.3 ± 3.0	< 0.001*	4.7 ± 1.8	1.3 ± 1.1	< 0.001*	55.5 ± 11.3	7.8 ± 4.0	< 0.001*
Education												
≤ elementary (n = 117)	12.2 ± 2.8	1.1 ± 1.4	< 0.001*	39.5 ± 7.3	5.9 ± 4.8	< 0.001*	4.8 ± 1.8	1.2 ± 0.8	< 0.001*	56.4 ± 10.0	8.2 ± 5.3	< 0.001*
junior high (n = 24)	13.1 ± 3.1	0.9 ± 1.1	< 0.001*	38.9 ± 8.3	6.0 ± 3.5	< 0.001*	5.0 ± 2.0	1.4 ± 1.0	< 0.001*	57.0 ± 10.4	8.3 ± 3.7	< 0.001*
≥ senior high (n = 17)	10.0 ± 3.6	0.8 ± 1.5	< 0.001*	35.8 ± 7.6	4.7 ± 2.2	< 0.001*	3.7 ± 1.9	1.4 ± 1.6	< 0.001*	49.5 ± 11.4	6.8 ± 3.1	< 0.001*
Occupation												
none (n = 67)	12.3 ± 2.9	1.2 ± 1.4	< 0.001*	39.1 ± 7.5	5.8 ± 3.4	< 0.001*	4.5 ± 2.1	1.2 ± 0.8	< 0.001*	55.9 ± 10.3	8.2 ± 4.2	< 0.001*
office worker (n = 55)	11.8 ± 3.3	1.0 ± 1.2	< 0.001*	38.6 ± 9.0	6.6 ± 6.2	< 0.001*	4.7 ± 1.7	1.4 ± 1.1	< 0.001*	55.1 ± 12.1	8.7 ± 6.3	< 0.001*
blue-collar worker (n = 36)	12.1 ± 2.6	1.0 ± 1.5	< 0.001*	39.4 ± 4.9	4.6 ± 2.3	< 0.001*	5.1 ± 1.5	1.3 ± 1.1	< 0.001*	56.6 ± 7.2	6.9 ± 3.2	< 0.001*
Prosthesis												
NIHT (n = 128)	12.0 ± 3.0	1.1 ± 1.5	< 0.001*	39.0 ± 7.9	6.0 ± 4.7	< 0.001*	4.9 ± 1.7	1.3 ± 1.0	< 0.001*	55.8 ± 10.7	8.4 ± 5.3	< 0.001*
self-paid (n = 30)	12.2 ± 3.2	0.7 ± 0.7	< 0.001*	39.2 ± 5.7	4.9 ± 2.8	< 0.001*	4.0 ± 2.4	1.1 ± 0.9	< 0.001*	55.4 ± 9.1	6.7 ± 2.7	< 0.001*

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; TKR: total knee replacement; BMI: body mass index; NIHT: National Health Insurance of Taiwan; NA: not applicable

*Significant difference ($p < 0.05$)

Table 2. Stratification of patients by WOMAC score into less than 80% improvement, greater than 80% improvement, and worse outcome after TKR operation for each variate.

Variate	Pain				Function				Stiffness				WOMAC			
	< 80%	≥ 80%	Worse	*p*	< 80%	≥ 80%	Worse	*p*	< 80%	≥ 80%	Worse	*p*	< 80%	≥ 80%	Worse	*p*
Gender				1.000				0.742				0.788				0.101
male	4	30	0		6	28	0		16	16	2		9	25	0	
female	14	110	0		19	105	0		52	61	11		18	106	0	
Age				0.196				0.184				0.533				0.307
≤ 64	1	32	0		5	28	0		15	14	4		3	30	0	
65 – 79	12	83	0		12	83	0		37	51	7		17	78	0	
≥ 80	5	25	0		8	22	0		16	12	2		7	23	0	
BMI				0.766				0.498				0.253				0.112
18.6 – 24	3	33	0		7	29	0		14	21	1		3	33	0	
≥ 24.1	15	107	0		18	104	0		54	56	12		24	98	0	
Knee site				0.501				0.009*				0.669				0.401
right	8	74	0		19	63	0		38	38	6		16	66	0	
left	10	66	0		6	70	0		30	39	7		11	65	0	
Education				0.616				0.392				0.676				0.810
≤ elementary	15	102	0		17	100	0		49	60	8		21	96	0	
junior	2	22	0		6	18	0		10	11	3		3	21	0	
≥ senior	1	16	0		2	15	0		9	6	2		3	14	0	
Occupation				0.416				0.114				0.085				0.471
none	10	57	0		11	56	0		23	35	9		9	58	0	
office worker	4	51	0		12	43	0		28	23	4		12	43	0	
blue-collar worker	4	32	0		2	34	0		17	19	0		6	30	0	
Prosthesis				0.025*				0.788				0.166				0.026*
NIHT*	18	110	0		21	107	0		57	63	8		26	102	0	
self-paid	0	30	0		4	26	0		11	14	5		1	29	0	

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; BMI: body mass index; NIHT: National Health Insurance of Taiwan

*significant difference ($p < 0.05$)

Table 3. Odds ratios for each variate among patients that experienced greater than 80% improvement in WOMAC score after TKR operation.

Variate	Pain				Function				Stiffness				WOMAC			
	OR	95% CI of OR		*p*	OR	95% CI of OR		*p*	OR	95% CI of OR		*p*	OR	95% CI of OR		*p*
Gender																
male	1.000				1.000				1.000				1.000			
female	0.955	0.293	3.113	0.939	0.844	0.308	2.314	0.742	0.918	0.429	1.963	0.825	0.472	0.190	1.173	0.472
Age																
≤ 64	1.000				1.000				1.000				1.000			
65 – 79	0.216	0.027	1.731	0.149	1.235	0.400	3.815	0.714	1.573	0.707	3.499	0.267	0.459	0.125	1.680	0.039*
≥ 80	0.156	0.017	1.424	0.100	0.491	0.141	1.712	0.264	0.905	0.331	2.472	0.845	0.329	0.076	1.411	0.034*
BMI																
18.6 – 24	1.000				1.000				1.000				1.000			
≥ 24.1	0.648	0.177	2.378	0.514	1.395	0.531	3.661	0.499	0.606	0.286	1.286	0.192	0.371	0.105	1.313	0.124
Knee site																
right	1.000				1.000				1.000				1.000			
left	0.714	0.266	1.915	0.503	3.519	1.322	9.365	0.012*	1.220	0.653	2.280	0.532	1.433	0.618	3.320	0.042*
Education																
≤ elementary	1.000				1.000				1.000				1.000			
junior	1.618	0.345	7.589	0.542	0.510	0.177	1.468	0.212	0.804	0.333	1.940	0.627	1.531	0.418	5.611	0.520
≥ senior	2.353	0.291	19.056	0.423	1.275	0.267	6.082	0.761	0.518	0.180	1.494	0.224	1.021	0.269	3.873	0.976
Occupation																
none	1.000				1.000				1.000				1.000			
office worker	2.237	0.667	7.573	0.196	0.704	0.283	1.748	0.449	0.657	0.320	1.349	0.252	0.556	0.215	1.438	0.226
blue-collar worker	1.404	0.407	4.839	0.591	3.339	0.698	15.982	0.131	1.022	0.454	2.300	0.958	0.776	0.252	2.385	0.658
Prosthesis																
NIHT	1.000				1.000				1.000				1.000			
self-paid	0.859	0.801	0.922	0.025*	1.276	0.403	4.037	0.679	0.903	0.407	2.002	0.801	7.392	0.962	56.819	0.029*

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; BMI: body mass index; NIHT: National Health Insurance of Taiwan; CI: confidence interval
*significant difference ($p < 0.05$)

80 years or above and those who had a BMI above 24.1. Those with at least a senior education or office workers had higher chances of improvement. On the contrary, the ratio of the prosthesis type was not significant. Stiffness did not improve in 18 patients, and worsened in six patients with postoperative type 1 stiffness (morning stiffness), and in two patients with type 2 stiffness (stiffness later in the day), as shown in Table 4.

Table 4. Analysis of stiffness type among patients experiencing no improvement or worse outcomes in the stiffness subcategory (n = 13) after total knee replacement.

Results	Total		Stiffness 1*		Stiffness 2*	
	n	%	n	%	n	%
No change (score = 0)	18	69.2	7	53.8	11	84.6
Worsened (score ≥ 1)	8	30.8	6	46.2	2	15.4

1*: morning stiffness; 2*: stiffness later in the day

Discussion

OA patients are typically burdened with disability and reduced quality of life with an increased mortality.[2] Although TKR is the best choice to treat disability of the knee joint, the long-term outcome is affected by postoperative rehabilitation and exercise.[6,11] Previous studies have demonstrated that operative and exercise programs can enhance patient outcomes through improving self-efficacy and self-reliance as well as reducing helplessness and disability.[12,13] Exercise can effectively increase confidence in the ability to perform certain health activities.[14] For patients with joint pain, exercise is perceived to be a burdensome and time-consuming activity that causes pain. The quality of life usually depends on many physical, behavioral, and social factors that are not included in the functional outcome scores. A previous study has identified patient-related factors, surgical skills, and post-TKR rehabilitation as predictors of the therapeutic effect of TKR in patients who returned to work and in those who chose to stay at home.[3] Preoperative education may be effective for lowering the risk of undesirable effects in certain patients, including those with depression, anxiety, or unrealistic expectations, who may achieve better outcomes as a result of preoperative education that suits their physical, psychological, and social needs.[15,16] Therefore, the improvements differed for different patient backgrounds, such as level of personal education (recognition of disease) and profession (time to exercise), and for patients with different levels of pain and physical function.

A previous study has demonstrated that the WOMAC score of patients after receiving TKR who experienced improvements (n = 211, 78.4%) compared to those who did not (n = 58, 21.6%) was worse for pain (p = 0.002) and disability ($p < 0.001$).[17] Preoperative measures that were predictors of improvement included higher WOMAC disability (OR = 1.08, $p < 0.001$), presence of chronic OA symptoms in the surgical knee (OR = 5.77, p = 0.033), absence of OA-related symptoms in the contralateral knee (OR = 9.25, $p < 0.001$), and exposure to frequent knee bending (OR = 3.46, p = 0.040).[17] A comparison study of improved and unimproved patients also found higher preoperative WOMAC pain scores (39.3 vs. 22.7, $p < 0.0001$), disability (39.2 vs. 18.2, $p < 0.0001$), and stiffness (46.5 vs. 27.4, $p < 0.0001$) subscale scores, and recognized a minimal importance difference.[17,18] After subgroup analysis, patients with improvement were more likely to have higher OA pain and disability prior to surgery than the unimproved patients. In our study, 7 patients (4.4%) aged over 80 years and 11 patients (7.0%) whose left knees were operated on did not experience improvement in terms of their total WOMAC scores. Physical therapeutic exercise, community-based group exercise, and usual care as

a control arm were evaluated with WOMAC scoring after TKR.[13] Performance-based tests demonstrated greater improvement in the physical therapy group compared to both the community (98.3% CI, 0.0 – 0.2) and control (98.3% CI, 0.1 – 0.4) groups, and in the community group compared to the control group (98.3% CI, 0.0 – 0.3). Therefore, various factors associated with older age and a BMI over 40 influence TKR outcomes based on different strategies in our clinical practices.[7]

Concerning the outcome factors, obesity may be a risk factor. Participants with a higher BMI had worse preoperative WOMAC, pain, and function scores, and experienced greater improvement from baseline to three months. The mean changes in pain and function between three to six months and from six to 24 months were similar across all BMI groups.[19] In our study, participants with a BMI over 24.1 were less likely to experience improvement. Body fat percentage should be considered when predicting clinical and functional outcomes at two years following TKR instead of BMI.[20] Body fat percentage may help surgeons with risk stratifications to predict patient-reported functional outcomes, and to better educate obese patients about postoperative expectations prior to undergoing elective total joint replacement. The symptoms of stiffness increased for 129 patients (5%), with a mean decrease in the WOMAC stiffness score of 20.0 at 12 months after TKR when compared to their preoperative score.[21] There was improvement in the pain and function subscales in our patients, but not stiffness. We speculate that this was due to the poor WOMAC function scores of some patients. However, we did not find statistically significant associations between function and stiffness. In addition, numbness was commonly reported after TKR but is not associated with worse reported patient outcomes.[22] Furthermore, the current study showed that Asian TKR patients with significantly worse preoperative scores had postoperative outcomes comparable to their North American counterparts. The higher preoperative functional deficit and the higher pain levels in the Asian population may be due to cultural differences or socioeconomic factors, which leads to the presentation of more severe conditions during preoperative consultation for potential surgical treatment in Asian patients compared to those in North America.[22] Gender does not clinically influence the WOMAC score one year after TKR. However, satisfaction with pain relief after TKR was significantly less in female patients.[23] There was little evidence to suggest a difference in outcomes according to glycemic control. The associations between diabetes and worse postoperative outcomes in patients undergoing TKR for OA appear to be predominantly due to associated obesity and comorbidities.[24]

Conclusion

Preoperative education and early postoperative exercise are strongly encouraged where possible, and exercise is expected to be more effective after TKR. Based on the primary outcome, participation in late-stage exercise programs after TKR offered no benefit over the usual care.[13] Besides, not only may bias arise from variations in the rehabilitative setting (i.e., under one-on-one instructions, community-based training, self practice) but it could also vary with individual differences in the ability of concentration as well as the intensity and amount of exercises. Improvement after TKR was satisfactory and early rehabilitation is encouraged, regardless of outcome variates.

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