Comparing Unilateral and Bilateral Total Knee Replacement Based on the Functional Approach

Ali Asghar Jamebozorgi [1], Ladan Zakeri [1*], Amir Hossein Kahlaee [2], Hamed Ghomashchi [3], Ashkan Irani [1]

1. Department of Occupational Therapy, Faculty of Rehabilitation, Shahid Beheshti University of Medical Sciences & Health Services, Tehran, Iran.
2. Department of Physical Therapy, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.
3. Department of Mechanical Engineering, Faculty of Industrial and Mechanical Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran.

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ABSTRACT

Purpose: Total Knee Replacement (TKR) is the treatment of choice for severe osteoarthritis with acceptable outcomes regarding pain management, function and quality of life enhancement. Because many patients require TKR procedure for their both knees, there has always been a challenge in the choice of simultaneous or consecutive operations. The aim of the present study was to compare the two protocols based on functional capabilities of patients with osteoarthritis (OA).

Methods: In this quasi-experimental study, twenty five severe patients with OA candidates for bilateral TKR (sampled by simple convenient method) were assigned into unilateral (3 men, 9 women) and bilateral (3 men, 10 women) groups based on the preference of the patients for the surgery procedure. Knee Injury and Osteoarthritis Outcome Score (KOOS) was used to evaluate functional capabilities of the patients prior to and 6 weeks after the operation and rehabilitation program. Repeated measures analysis of variance was used for the statistical analysis by SPSS 21 software.

Results: The findings indicated that the KOOS scores of the 2 groups were not significantly different before or after the interventions. Besides, patients in both groups showed significant improvement after TKR and the following rehabilitation program ($P<0.01$ for both groups and all KOOS subscales).

Conclusion: TKR and the post-operative rehabilitation program could significantly enhance function of the severe OA patients but no priority for either unilateral or simultaneous bilateral methods was recognized.

1. Introduction

Osteoarthritis (OA) is the most common progressive degenerative disease involving the hyaline cartilage covered joints. The knee is the most commonly involved joint and the progression of the disease leads to considerable disability and functional capacity limitation during various spectrum of activities of daily life. Within the aging process, OA becomes a major health problem because of biological dysfunctions [1]. Various treatments have been suggested for symptom reduction and function improvement in these patients. Total Knee Replacement (TKR) is currently the procedure of choice in advanced stages of OA. Considerable pain reduction and improvement in function and Quality of Life (QOL) besides low rate of comorbidity have led to increasing popularity of the procedure [2]. Most studies investigating the efficacy of TKR have focused on the functional capacity of the patients and their QOL. These two parameters are the major ones capable of assessing the intervention outcomes from the patients' point of view. The functional capabilities and QOL are determining factors indicating public health and health improve-

* Corresponding Author:
Ladan Zakeri, MSc.
Address: Department of Occupational Therapy, Faculty of Rehabilitation, Shahid Beheshti University of Medical Sciences & Health Services, Tehran, Iran.
Phone: +98 (936) 9925013
Email: l_zakeri@sbmu.ac.ir

ment and are thus acceptable items for the evaluation of the effectiveness of gross and expensive treatment procedures like TKR [3]. Patients usually consider pain reduction, lower limb function enhancement and return to normal daily activities while assessing their QOL improvement [4]. Multiple studies have investigated pain reduction and functional improvement after TKR using WOMAC (Western Ontario and McMaster Universities osteoarthritis index), KOOS (Knee Injury and Osteoarthritis Outcome Score), SF-36 (Short Form Health Survey 36), KSS (Knee Society Score) questionnaires and other valid tools all of which were indicative of pain reduction, functional improvement and QOL enhancement [3, 5-12].

Most patients exhibit degenerative changes in their both knees. A 17-year survey revealed that most patients with knee OA need bilateral TKR [13]. When the patients need a second operation for their next knee, there are considerations for the repetition of the surgery procedure and anesthesia side-effects and a second rehabilitation process [14]. As there is a high rate of indication for bilateral operation, the choice of simultaneous or unilateral (consecutive) TKR is a challenge for physicians and patients. There is a wide range of controversial evidence indicating the preference of unilateral [13, 15-21], lack of preference [13, 20-24] and in favor of simultaneous bilateral procedure [13, 16, 18, 23, 25-27]. Thus, the purpose of the current study was to compare the functional outcomes of the unilateral and simultaneous TKR operations. It was hypothesized that patients with bilateral TKR would have better function than those with unilateral TKR operation.

2. Materials & Methods

This study had a semi-experimental pre-test, post-test design. Twenty five patients with primary, severe OA admitted to Akhtar Orthopedic Hospital between September 2013 and July 2014 and candidate for bilateral TKR were selected by simple convenient method, recruited into the study and assigned into either unilateral (n=12, 3 men and 9 women) or bilateral TKR group (n=13, 3 men and 10 women). All patients were candidate for bilateral TKR and the patients in the unilateral group were unwilling for bilateral TKR for non-medical purposes. The background characteristics of the participants are reported in Table 1. Severe patients with OA (grades III and IV based on Kellgren-Lawrence criteria) [28] were included in the study. The participants had no history of lower limb operations or any balance or visual disorders affecting their gait and took no medications affecting balance control. These criteria were checked by assessment of the patients and their self-report and medical records. The patients were recruited into the study after familiarization with the content and aims of the study and signing an informed consent form approved by the Human Ethics Committee of Shahid Beheshti University of Medical Sciences & Health Services,. All patients were undergone TKR by cemented, medial para-patellar, and posterior cruciate ligament retaining method performed by a single orthopedic surgeon. All patients received rehabilitation after the surgery including pain management, exercises for Range of Motion (ROM) regaining and muscular strength enhancement. The rehabilitation service was delivered on a daily basis for the first week post-operative and 3 sessions a week thereafter for 5 weeks. The exercises majorly included active ankle pumping for deep venous thrombosis prevention and edema control, active and active-assisted ROM exercises of knee flexion and extension, strengthening knee joint musculature with special emphasis on knee extensors by isometric method progressing to isotonic exercise via the DAPRE (Daily Adjustable Progressive Resistance Exercise) protocol [29] and gait education with walker and cane. Exercise performance was supervised by a physiotherapist.

All patients filled the KOOS questionnaire within 3 days pre-operatively and 6 weeks after the operation. KOOS has been found to be a reliable and valid tool for the evaluation of the consequences of knee OA and treatment outcomes [30]. The KOOS questionnaire is a patient centered instrument for evaluation of the consequences of knee injuries and OA and as well as the outcomes of the relevant treatment procedures such as cruciate ligament reconstruction, meniscectomy and TKR. This questionnaire includes 42 items in 5 subscales: stiffness and other symptoms (7 questions), pain (9 questions), Activities of Daily Living (ADL) (17 questions), sports and recreational activities (5 questions) and knee-related QOL (4 questions). The KOOS questionnaire has been developed based on the WOMAC questionnaire and uses a 5 scale Likert system for scoring the questions. All items have 5 possible answer options scored from 0 (no problems) to 4 (extreme problems) and each of the 5 scores is calculated as the sum of the items included. The score of each subscale is divided by the maximum possible score of that subscale. Because in orthopedics higher grades have traditionally been considered as better health condition and zero as the worst, the scores of the subscales were normalized to adapt this categorization [31]:

Table 1. Comparison of demographic variables of the patients between two groups by independent t-test.

Variable	Mean(±SD)		P-Value
	Unilateral (n=12)	Bilateral (n=13)	
Age (y)	67.58 (±6.11)	68.15 (±6.90)	0.82
Height (cm)	160.50 (±8.96)	161.08 (±9.95)	0.88
Weight (kg)	77.92 (±12.68)	77.77 (±10.25)	0.97
BMI (kg/m^2)	30.13 (±3.45)	30.01 (±3.46)	0.93

PHYSICAL TREATMENTS

$$\text{Subscale normalized score} = 100 - \frac{100 \times \text{raw score of the subscale}}{\text{maximum possible score of the subscale}}$$

The Persian version of the questionnaire, which was used in this study, has good validity and reliability was utilized in this study [31]. Repeated measurement of analysis of variance was used to check the interactive and main effects of the independent variables. Post hoc comparison was performed to explore the differences when the main effects were statistically significant ($P<0.05$) SPSS software version 21 was used for statistical analysis.

3. Results

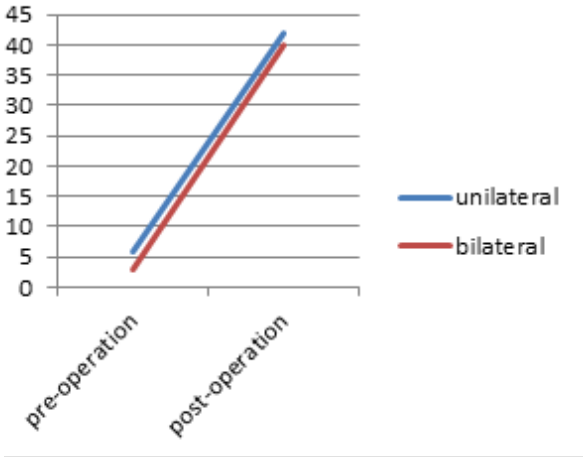
The results revealed no significant difference between the groups based on demographic variables (Table 1). Kolmogorov-Smirnov test results showed that all variables have normal distribution ($P>0.05$).

The findings were not statistically different before or after TKR with respect to any subscale. However, in both groups, TKR and the following rehabilitation program significantly enhanced all subscales of the KOOS questionnaire (Table 2).
Quality of life suscale score and total score of KOOS for both groups before and after operation are reported in Figure 1 and 2 respectively

4. Discussion

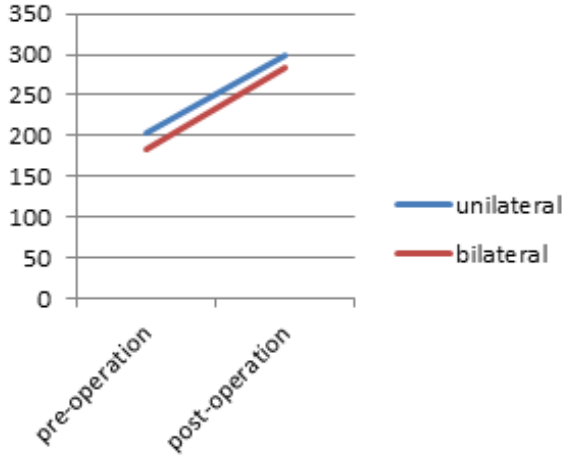
The purpose of the current study was to compare the effect of unilateral and bilateral TKR on functional capabilities of patients with severe OA. The patients were evaluated before and 6 weeks after the operation, when the post-operation rehabilitation program was completed. All KOOS subscales were improved in both groups but the differences after treatment were insignificant.

Previous studies using KOOS and other functional measures had also shown the TKR effectiveness in patients with OA [32-36]. A systematic review on 31 studies has confirmed the effectiveness of this procedure on the function of patients with OA [3]. The improvement was reported both in short term (1, 4 and 6 weeks) [5, 10, 37] and long term (7 years) [8] investigations. OA is a progressive disease which ultimately leads to the destructions of the peri-articular joint structures such



PHYSICAL TREATMENTS

Figure 1. Quality of Life subscale score



PHYSICAL TREATMENTS

Figure 2. Total score of KOOS

Table 2. Pairwise comparisons of the KOOS questionnaire subscales within and between groups.

KOOS subscales	Unilateral		Bilateral		Within groups (P-Value)		Between groups (P-Value)	
	Pre-op	Post-op	Pre-op	Post-op	Unilateral	Bilateral	Pre-op	Post-op
Stiffness	52.67 (±12.19)	70.82 (±8.98)	54.39 (±62.32)	67.02 (±10.92)	<0.01	<0.01	0.72	0.35
Pain	65.04 (±13.26)	81.70 (±11.45)	52.77 (±19.27)	72.21 (±14.16)	<0.01	<0.01	0.07	0.08
Activity of daily living	68.38 (±14.68)	80.14 (±14.00)	59.38 (±25.63)	81.10 (±13.60)	<0.01	<0.01	0.29	0.86
Sport and recreation activities	12.50 (±13.05)	27.08 (±19.82)	13.07 (±12.67)	23.84 (±19.27)	<0.01	<0.01	0.91	0.68
Quality of life	6.25 (±10.98)	42.18 (±14.38)	3.84 (±8.66)	40.38 (±16.46)	<0.01	<0.01	0.54	0.77
Total score	204.84 (±48.84)	300.56 (±53.97)	183.47 (±62.32)	284.58 (±57.09)	<0.01	<0.01	0.35	0.48

Pre-op: pre operation, Post-op: post operation

as joint capsule, synovium, menisci and bony joint surfaces. Bone erosion will cause pain, stiffness and limited mobility. Another consequence of bone erosion is altered distribution of loads to the joint surface which will cause microtrauma and continuous inflammation and swelling. The resultant pain, swelling, loss of ROM and stiffness will lead to considerable loss of function during ADL [38]. Removing bony erosions and realignment of joint surfaces will reverse these consequences and thus provide pain-free mobility and more function for the patient with OA.

Knee muscular weakness is an early sign of OA even in the absence of pain. The possible mechanism is the impaired efferent inputs to the (Central Nervous System) CNS by the altered joint soft tissue structures hosting the mechanoreceptors [39]. The result will be reduction in α-motor neuron pool to the knee muscles and less efficient motor response to the dynamic demands of the patients which is one of the explanations for poor balance control and high risk of fall in these patients with OA (40). TKR and the following rehabilitation program can compensate for these alterations through reducing incorrect proprioceptive input, removing the reflexive muscle inhibition and improving the knee muscles strength [41]. Better muscular performance along with less impaired sensory afferent may improve body balance and reduce the risk of falling. However, that the invasive nature of the surgical procedure itself may play an inhibitory role for knee musculature. That is why some studies found falling a consequence of TKR [42]. This point emphasizes the role rehabilitation after TKR to prevent the adverse effects.

Although some studies along with ours have found improvement in function even in short term follow-up, some failed to show such improvement until at least three months after operation [37, 43]. This discrepancy might be due to different patient populations with varying degrees of OA severity and disabilities. The initial state of the patient seems to be a determining factor in the treatment efficacy and outcome.

The major finding of this study was the lack of significant difference between the two surgical procedures according to the functional outcomes of the patients with OA. Few studies have compared the outcomes of these two protocols and most have investigated function of patients with OA in any of the procedures separately. A study in 2003 showed that the unilateral group got lower scores on KSS than the bilateral one [45]. Also, a retrospective study in 2015 found that the bilateral group had better function and ROM, though the KSS subscales were not different between the groups [46]. However, another study using WOMAC, SF-12 and (Time Up and Go) TUG instruments, showed that the unilateral group compared to bilateral group was in better condition but after one year follow-up [47]. The outcome measures in these studies have been so various that direct comparison is not feasible. The findings of our study showed no priority for either method. It is suggested that prioritization of the TKR surgery should be based on factors other than functional ability.

The findings of the current study showed that both unilateral and bilateral TKR and subsequent rehabilitation effectively enhanced function of patients with OA. The two methods seem not to be different regarding function improvement.

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