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Physical Function after Total Knee Replacement: An observational study describing outcomes in a small group of women from China and the United States

Daniel K. White, PT, ScD[1], **Zhichang Li, MD**[2], **Yuqing Zhang, DSc**[3], **Adam R. Marmon, PhD**[1], **Hiral Master, PT, MPH**[1], **Joseph Zeni, DPT, PhD**[1], **Jingbo Niu, DSc**[3], **Long Jiang, MD**[2], **Shu Zhang, MD**[4], and **Jianhao Lin, MD**[2]

[1]Department of Physical Therapy, University of Delaware, Newark, DE

[2]Peking University People's Hospital, Peking University, Beijing, China

[3]Boston University School of Medicine, Boston, MA

[4]First People's Hospital of Dongcheng District, Beijing, China

Abstract

Objective—To describe physical function before and six months after Total Knee Replacement (TKR) in a small sample of women from China and the United States (US).

Participants—60 women after TKR from China and the US

Design, Setting, Outcomes—Data was from an observational study of TKR outcomes in Newark, Delaware (US group) and a control group after TKR in Beijing (China group). Both groups followed the same Osteoarthritis Research Society International (OARSI) protocols for the six-minute walk and 30-second chair stand. We compared physical function prior to TKR and six months after using linear regression adjusted for covariates.

Results—Age and BMI were similar in the China group (n=30, 66 years and 27.0 kg/m^2) as the US group (n=30, 65 years and 29.6 kg/m^2). Before surgery, the China group walked 263 (95%CI [−309, −219]) less meters and had 10.2 (95%CI [−11.8, −8.5]) fewer chairs stands than the US group. At six months when compared to the US group, the China group walked 38 more meters, but this difference did not reach statistical significance (95%CI [−1.6, 77.4]), and had 3.1 (95%CI [−4.4, −1.7]) fewer chair stands. The China group had greater improvement in the six-minute walk compared with the US group, p< 0.001.

Corresponding author: Daniel K. White PT, ScD, MSc, 540 South College Ave, 210L, Newark, DE 19713, P: (302) 831-7607, F: (302) 831-4234, dkw@udel.edu.

IRB Approval

Informed consent was obtained from each study participant, the rights of the subjects were protected, and the study was approved by the Institutional Review Board at People's Hospital and at the University of Delaware.

We affirm that none of the authors have any financial affiliation (including research funding) or involvement with any commercial organization that has a direct financial interest in any matter included in this manuscript.

Conclusion—Despite having worse physical function prior to TKR, the China group had greater gains in walking endurance and similar gains in repeated chair stands compared with the US group after surgery.

Keywords

Total Knee Replacement; Physical Function

Introduction

Total Knee Replacement (TKR) is the definitive treatment for knee osteoarthritis (OA) and an effective intervention to address OA-related functional limitation. While outcomes after TKR have been well-established in North America and Europe, [1] little is known about physical function following TKR in China.

Physical function after TKR may differ in China compared with the US because of major differences in the delivery of perioperative care for TKR between countries. First, people in China may wait longer to have TKR since the out-of-pocket cost for surgery roughly equates one year's salary in China.[2] Second, surgery is followed by two weeks of inpatient rehabilitation in China, after which a home exercise program is prescribed and patients no longer receive supervised therapy. This is in contrast to the US where patients are discharged home three to four days after surgery and receive six to eight weeks of outpatient rehabilitation.[3]

At present, there are no data that describe the recovery of physical function after TKR in China. We were particularly interested in investigating performance-based measures of physical function, in order to minimize differences due to cultural norms or translation inherent in self-reported instruments. We conducted a study utilizing a small group of women undergoing a unilateral TKR in China and the US to provide an exploratory description of physical performance outcomes before and six months after TKR.

Methods

We conducted an analysis on two existing datasets, one from China and another from the US.

China group—We used data from a randomized controlled trial whose purpose was to promote an increase physical activity after TKR. The study recruited sequential admissions of women from Beijing, China from 10/1/2013 to 3/1/2014 with end-stage knee OA by radiograph (Kellgren and Lawrence grade IV) who were scheduled for TKR at Peking University People's Hospital. The study included women who elected a first time TKR for unilateral knee OA, were between 55 and 75 years of age, lived in Beijing for the duration of the study period, and excluded women with function limiting-comorbidities other than arthritis. Rehabilitation included use of a Continuous Passive Motion (CPM) machine, passive knee flexion range of motion, and supervised stationary bicycling and supervised climbing three to five steps with a handrail five days a week for 30 to 60 minutes/day.

Informed consent was obtained from each study participant, and the study was approved by the Institutional Review Board at People's Hospital.

US group—Sequential women enrolled in an ongoing observational study that evaluated functional outcomes and clinical impairments prior to and at regular time points after TKR from 6/17/2013 to 7/23/2014 were included in our study. Study subjects were recruited from the Center for Advanced Joint Replacement at Christiana Care Health Systems, Newark, Delaware. Study subjects who were between the age of 40 and 85 years and had a planned elective TKR for knee OA were recruited via mailings 3 to 4 weeks prior to surgery. Participants were included if they were undergoing a unilateral TKR and excluded if they were undergoing a revision TKR or were having TKR for a condition other than OA. Study inclusion was not restricted based on comorbidity status. Immediately after surgery, study participants receive rehabilitation to address impairments in range of motion, pain, and functional mobility.

Outpatient rehabilitation lasted for 60 minutes two times/week and included passive stretching to increase knee flexion and extension range of motion, strengthening exercise for the hip and knee, and balance training in physical therapy. Informed consent was obtained from each study participant, and the study was approved by the Institutional Review Board at the University of Delaware.

For both groups, the surgical approach was a tricompartmental cemented endoprosthesis with a medial parapatellar approach. Study outcomes were assessed before TKR and at six months after TKR.

Study outcomes

Research assistants in China and the US administered the six-minute walk test and the 30 seconds chair stand test,[4] consistent with OARSI protocol.[5]

Six-minute walk—Subjects are asked to cover as much distance as they can while walking on level ground for six minutes. Participants were permitted to use an assistive device and could rest as needed. Distance covered is recorded in meters.[6]

30-second chair stand—Subjects are seated, asked to place their hands on opposite shoulders, stand up and sit down as many times as possible for 30 seconds. Participants were encouraged to not use their hands to stand. The total number of chair stands completed over 30 seconds was recorded.[7]

Covariates—Baseline age and BMI (calculated from standardized height and weight measures), were used as covariates. Subjects reported if they were retired. Comorbidities were measured with a self-reported health history form that includes a review of 38 common health problems. We list the proportion who sought medical treatment for hypertension, diabetes, osteoporosis, and cardiovascular disease.

Statistical Analysis

We describe mean and the standard deviation of age and BMI for the two groups. We confirmed our study data were normally distributed using the Kolmogorov-Smirnov test. To compare physical function between the two groups, we calculated the mean difference and 95% confidence intervals (CI) between China and US groups at baseline, follow-up, and change from baseline to follow-up using linear regression adjusting for age, BMI, and comorbidity. For outcomes calculating change between groups, we additionally adjusted for baseline values. Listed p-values were two-sided with significance set at 0.05. SAS 9.4 (Cary, NC) was used for all analyses.

Results

The US group recruited 46 subjects and lost 16 by the 6-month follow-up, and the China group recruited 44, and lost 14 by the 6-month follow-up. Hence, each group contributed 30 women to the analytical dataset. The characteristics of the analytic sample are listed in Table 1. In general, characteristics were similar between groups with the exception of retirement and comorbidity. All subjects in the China group were retired versus 70% from the US, and a higher proportion of those from China had hypertension and cardiovascular disease, compared with the US (63% versus 40% for hypertension, and 23% versus 7% for cardiovascular disease, respectively). After TKR, people from the US received a median of 31.5 days of rehabilitation mixed between outpatient, home to outpatient, home only, and inpatient to outpatient rehabilitation. People in China received a median of 14 days of inpatient rehabilitation.

Prior to TKR, the China group walked 213 meters (95% CI [174.8, 251.2]) during the six-minute walk and rose 3.0 times from a chair in 30 seconds 95% CI [1.8, 4.2]. This was less than the US group, which walked 398.7 meters [359.8, 437.6] and had 11.3 chair stands 95% CI [10.1, 12.5]. These differences were statistically significant ($p < 0.01$). Table 2

Six months after TKR, the China group walked 542.6 meters 95% CI [511.4, 573.9] which was more than the 446.8 meters the US group walked 95% CI [415.6, 478.1], though the difference did not meet statistical significance. The China group stood from a chair 12.0 times in 30 seconds 95% CI [11.1, 12.9] which was slightly less than the 13.8 times observed in the US group 95% CI [12.9, 14.8]. Improvement in physical function over six months was greater in the China group for the six-minute walk, but not the chair stands compared with the US group. Table 2

Discussion

We found noteworthy differences in performance-based physical function prior to and after TKR in the China group compared with the US group in this exploratory study. Before surgery, the China group walked about half the distance in six minutes as the US group, and could rise only three times from a chair in 30 seconds, compared with 11 times in the US group. In contrast, we found the China group to have substantially more improvement in the six-minute walk compared with the US group by six months. This was unexpected given that baseline function is a strong predictor of future functioning in people after TKR.[8]

To date, there are not studies directly comparing physical function in people before and after TKR in people in China with the US. However, previous individual studies may support evidence showing worse physical functioning in Asia[9] compared with western countries. One speculative reason for differences between groups in is that people in China are known to walk more and have more vigorous intensity physical activity than those in the US.[12] Given the preliminary and exploratory nature of our study, however we are unable to formally test differences in physical activity between countries. Nevertheless, our preliminary findings, if confirmed by others, highlight the need to better understanding the mechanisms leading to improvement in physical function after TKR.

Study Limitations

Our study has several limitations. First, we adjusted for a limited number of covariates, and residual confounders may account for our findings. For instance, we did not have data on education, the knee OA severity prior to surgery, nor pre-surgical knee pain intensity. However, it is possible that people in China had less education and worse knee OA severity than their US counterparts. Hence, the improvements in function in the China group may be underestimated after TKR. Second, we had a small number of subjects in our analytic dataset and it is not known if our study findings can generalize to typical patients undergoing TKR in China and the US. Hence, findings from our study are preliminary in nature and should be interpreted with caution. Lastly, a high proportion of subjects were lost to follow-up and we do not have data describing the reasons for drop out.

Conclusion

Despite having worse physical function prior to TKR, the China group had greater gains in walking endurance compared with the US group after surgery. Furthermore, physical function at six months was similar between groups. These findings provide a preliminary description of physical function outcomes after TKR in China compared with the US.

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Highlights

- It is not known to what extent physical function after Total Knee Replacement (TKR) may differ in China compared with the United States (US).
- Despite having worse physical function prior to TKR, the China group had greater gains in walking endurance and similar gains in repeated chair stands compared with the US group after surgery.

Table 1

Participant characteristics within the China and US group

	US Group n=30	China Group n=30
Age [years] [mean; standard deviation]	67.1; 7.8	65.7; 3.2
Sex [% women]	100	100
BMI [kg/m] [mean; standard deviation]	32.3; 8.5	27.2; 1.6
Retired [n (%)]	21 (70)	30 (100)
Duration of Rehabilitation [days] [mean; range]	37.8; 7 - 84	14.5; 9 - 22
Rehabilitation Setting [n (%)] *		
Inpatient-only	0 (0)	30 (100)
Inpatient to outpatient	4 (16)	0 (0)
Home	3 (12)	0 (0)
Home to outpatient	5 (21)	0 (0)
Outpatient	11 (45)	0 (0)
None	1 (4)	0 (0)
Comorbidity [n (%)]		
Hypertension	13 (43)	19 (63)
Diabetes	3 (10)	4 (13)
Cardiovascular disease	2 (7)	7 (23)
Osteoporosis	4 (13)	2 (7)

* Missing n=6 from the US

Table 2

Baseline, six-month, and change values for physical performance measures in China (n=30) compared to the US (n=30).

	Group	Unadjusted values [95% CI]	Adjusted* mean difference [95% CI] and p-value
Baseline Chair Stands (repetitions)	US China	11.3 [10.1, 12.5] 3.0 [1.8, 4.2]	Reference −10.0 [−11.8, −8.2] p < 0.001
Six-month Chair Stands (repetitions)	US China	13.8 [12.9, 14.8] 12.0 [11.1, 12.9]	Reference −2.6 [−4.0, −1.3] p = 0.003
Change (Six-month – Baseline) Chair Stands (repetitions)	US China	2.5 [1.6, 3.4] 9.0 [8.0, 9.9]	Reference 1.5 [−0.6, 3.6] p = 0.15
Baseline Six-Minute Walk (meters)	US China	398.7 [359.8, 437.6] 213.0 [174.8, 251.2]	Reference −262.7 [−312.4, −213.0] p < 0.001
Six-month Six-Minute Walk (meters)	US China	446.8 [415.6, 478.1] 542.6 [511.4, 573.9]	Reference 37.9 [−1.6, 77.4] p = 0.06
Change (Six-month – Baseline) Six-Minute Walk (meters)	US China	48.7 [28.1, 69.2] 329.6 [309.4, 349.8]	Reference 185.7 [136.2, 235.3] p < 0.001

*Adjusted for baseline age, BMI, and comorbidity. Change outcomes are additionally adjusted for baseline values of Chair Stands or Six-Minute Walk.