Preoperative Rehabilitation for Patients with Total Knee Arthroplasty

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ABSTRACT

Background and Purpose: *Total knee Arthroplasty (TKA) had evolved into a reliable and suitable surgical procedure to return patients to function. Little attention has been placed on the potential role, that exercises could play in preparation for joint replacement surgery. The purpose of this study was to compare the effects of preoperative physical therapy with the routine procedure of no preoperative physical therapy on pain and functional ability in patients scheduled for total knee Arthroplasty.* ***Patients and Methods:*** *Thirty patients, both sexes, their age ranged from 40 to 75 years, scheduled for total knee Arthroplasty were assigned into: experimental group received a 4-week preoperative exercise intervention prior to surgery and control group received no intervention prior to surgery. Outcome measures were: knee functional recovery (using the WOMAC index), quadriceps and hamstrings muscle strength. Patients were assessed at baseline, one day preoperative (experimental group only) and 6 weeks postoperatively.* ***Results:*** *Statistical analysis showed a non significant differences in WOMAC score and muscle strength between both groups postoperatively, although the experimental group had less mean percentage of change than the control group.* ***Conclusion:*** *Although there was no differences between the effects of preoperative and postoperative exercise programmes on pain and functional recovery among the two groups, a 4-week preoperative physiotherapy can improve preoperative functional recovery and muscle strength levels in patients undergoing TKA.*
Key Words: *Knee osteoarthritis, Total Knee Arthroplasty, WOMAC, Preoperative Physical Therapy, Exercises.*

INTRODUCTION

Osteoarthritis is an increasingly prevalent chronic disease of aging population and the leading cause of disability[6]. Progression of symptoms often leads to decreased mobility, deconditioning, and reduced functional status and quality of life[7,15].

Total knee arthroplasty (TKA) has been established as a valuable procedure for the management of patients with disabling knee osteoarthritis who have not had acceptable relief and functional improvement after conservative treatment and who are not candidate for other non ablative procedures[14,25].

Exercises are the corner stone of rehabilitation following joint arthroplasty surgery and other surgical procedures[31]. Such exercise are aiming to enhance physical function and improve physical outcomes after the surgery. Little attention, however, has been placed on the potential role exercises might play in preparation for surgery[3].

Recently, preoperative exercise interventions for patients undergoing joint arthroplasty surgery has been considered. A specifically designed exercise program for those patients may enhance their recovery after TKA and maximize the gains of the surgery by: reducing their hospitalization period, reduce the extent of utilization of rehabilitation facilities and facilitate the return to a more

independent and active life style[24.] However, few studies[1,4], have evaluated the effect of preoperative exercise intervention on recovery from total knee arthroplasty.

The purpose of this study was to investigate the effect of preoperative exercise intervention on the functional knee ability and muscle strength on patient undergoing TKA.

SUBJECTS, MATERIALS AND METHODS

Subjects

Thirty patients, both sexes, who were scheduled to have primary unilateral total knee arthroplasty at King Faisal Specialist Hospital and Research Center (KFSH and RC) in Riyadh, Saudi Arabia were selected for the study. Their age ranged from 40 to 75 years.

Inclusion criteria:

1- Saudi Male and Female patients.
2- Age between 40 to 75 years.
3- Not responding to conservative treatment and scheduled for elective total knee Arthroplasty.
4- Healthy and fit for surgery.
5- Should be able to walk (with or without aids) prior to surgery.

Exclusion criteria:

1- Patients who have severe pain and deformity in other joints that may interfere with physical activities and / or needs active management.
2- Patients who are not fit for surgery.
3- Patients above the age of 75 years and who are wheel chair bounded or bed ridden.
4- Patients with any neuromuscular disease.
5- Patients who underwent total knee Arthroplasty in the past.
6- Patients who will not adhere to the study program or fail to attend the physical therapy sessions.

This study was approved by the ethics committee of the rehabilitation department at College of Applied Medical Sciences in King Saud University, Riyadh, Saudi Arabia. Subjects were instructed and acquainted with the evaluation and treatment procedures orally and in writing prior to initial testing. All patients were operated by the same two surgeons at KFSH and RC, same surgical technique and received the same knee prosthesis.

Procedures

Prior to the initial testing visit, the scheduled admission of all patients were obtained from the primary total knee Arthroplasty waiting list in the admission office at KFSH and RC. When the patient gave his/her approval to participate, he/she was given an appointment to the physical therapy department at KFSH and RC for the initial visit.

At the initial testing visit, a brief explanation of the study was given to each patient including their full freedom to participate or withdraw from the study. Demographic data were then recorded which included: weight (Kg), height (cm), body mass index (BMI) and duration of symptoms (years).

A qualified female physical therapist was familiarized with the study protocol including the assessment and treatment procedures to carry over the female subjects.

Assessment procedures

Assessment was done at baseline, immediately one day before surgery and 6 weeks postoperatively for the experimental group, while in the control group assessment was done at baseline and 6 weeks postoperatively.

Functional knee ability:

General knee pain and function was assessed by having each subject complete the Western Ontario and McMaster University Osteoarthritis Index (WOMAC). WOMAC is a self administered tool that can yield a score for 3 dimensions specific to knee OA: pain (five questions), stiffness (two questions), and physical function (seventeen questions). This tool has been found to be sensitive to exercise interventions[21,30]. The items are scored with points from 0 to 4, where 0 indicates no pain and 4 indicates extreme pain. Muscle strength testing.

Isometric muscle strength:

Quadriceps and hamstrings isometric strength were tested using Hand Held Dynamometer (HHD) (Lafayette electronic Manual Muscle Test System model 01163, USA). After calibration, the instrument was used according to the manufacturer's instruction.

For quadriceps testing: patient was positioned in the sitting position at the edge of the bed with hips and knees flexed at 90º. The patient's waist was strapped with belt to prevent unwanted hip, pelvic girdle and lower trunk movements. The patients' hands were positioned across their chests. The HHD was fixed at distal part of the patient's tibia anteriorly. The "make test" method was used to measure the isometric quadriceps strength. The subjects were asked to build a maximal force for 2-seconds and hold it for 5 seconds then requested to stop. This method with the use of HHD is a reliable and valid for assessment of isometric quadriceps strength[8].

Isometric hamstrings strength was done from prone lying position with tested knee flexed at 90° and the HHD was fixed at the distal part of the patient's tibia posteriorly using the same procedure.

Treatment Intervention:

After the baseline measurements, Patients were assigned into two groups according to their geographical availability: patients from Riyadh were assigned to (experimental group) who performed preoperative exercise prior to their admission to the hospital and patients from outside Riyadh (control group) who didn't performed preoperative exercise prior to their admission to the hospital. This method of selection was used in previous research[23].

The experimental group:

Patients participated in preoperative exercise program to strengthen the upper and lower extremities and improve knee range of motion. This program included initial warming-up exercise for the upper and lower limbs using ergometer combined with breathing exercises using incentive spirometry. Initial stretching exercises for calf, hamstring, and quadriceps muscles, followed by isometric and isotonic strengthening exercises of the triceps surae, quadriceps, hamstrings, hip flexors, hip extensors, hip abductors, shoulder flexors. Shoulder abductors, and triceps brachii. Weights were used as tolerated by the patients.

Each session lasted from 30-45 minutes, 3 times weekly over a 4-week period immediately prior to surgery.

Postoperative Rehabilitation:

After surgery, subjects in both groups received exactly the same in-patient and out-patient rehabilitation programme, which includes: Breathing exercise, quadriceps and hamstring setting, straight leg raises, hamstring and calf stretching, knee strengthening, sitting and knee range of motion exercises, gait training program, and routine precautions.

Patient were referred to an outpatient clinic of physiotherapy to continue their rehabilitation program. Patients from Riyadh were scheduled at the physiotherapy outpatient clinic at KFSH and RC. Patients who were from outside Riyadh were given an official physiotherapy referral to their local hospitals that states clearly the type of surgery and what forms of physiotherapy patient needed.

Data Analysis

Data processing was done using the Statistical Package for the Social Sciences (SPSS) version 10. The Mean and standard deviations of the baseline, preoperative and postoperative variables in both groups were calculated. A paired t-test was conducted to compare between baseline, preoperative and postoperative changes within groups. Un paired t-test was conducted to compare between groups. Significance for all statistical tests was accepted at 0.05 level of probability.

RESULTS

Thirty patients met the inclusion criteria were assigned to participated in the study. Subjects characteristics are summarized in the table 1, in which there were no significant differences in age, height, weight and BMI between the two groups.

Table (1): Summary of demographic data for all groups.

	Control group (no= 15) Mean ± SD	Experimental group (no= 15) Mean ± SD	Significance
Age(year)	59.92 ± 6.44	59.25 ± 7.62	P>0.05
Height (cm)	157.3 ± 9.26	156.9 ± 8.81	P>0.05
Weight(Kg)	85.17 ± 24.45	84.92 ± 11.16	P>0.05
BMI(Kg/m²)	34.13 ± 8.05	33.89 ± 6.79	P>0.05
Duration of Symptoms(year)	10.91 ± 4.21	11.18 ± 4.31	P>0.05

Comparison within the two groups

Results of the Experimental group

Result of WOMAC Pain scale:

There were a significant decrease in pain score one day before surgery and 6-weeks postoperative compared with baseline assessment (P<0.05). There was a significant decrease in pain score 6-weeks postoperative compared with one day before surgery (P<0.05), as shown in table 2.

Results of WOMAC Stiffness scale:

There were a non significant differences in stiffness score one day before surgery and 6-weeks postoperative compared with baseline assessment (P>0.05). There was a non significant differences in stiffness score 6-weeks postoperative compared with one day before surgery (P>0.05), as shown in table 2.

Results of WOMAC Function scale:

There were a significant differences in function scale one day before surgery and 6-weeks postoperative compared with baseline assessment (P<0.05). There were a significant differences in function scale 6-weeks postoperative compared with one day before surgery (P<0.05), as shown in table 2.

Results of muscle strength:

There were a significant differences in quadriceps strength one day before surgery (P<0.05) and a non significant difference 6-weeks postoperative compared with baseline assessment (P>0.05). There were a significant differences in quadriceps strength 6-weeks postoperative compared with one day before surgery (P<0.05), as shown in table 2.

There were a significant differences in hamstring strength one day before surgery

(P<0.05) and a non significant difference between 6-weeks postoperative compared with baseline assessment (P>0.05). There were a significant differences in hamstring strength 6-weeks postoperative compared with one day before surgery (P<0.05), as shown in table 2.

Table (2): The means and standard deviations values for WOMAC score and muscle strength in the experimental group.

	Baseline	Before surgery	Baseline	Postoperative	Before surgery	Postoperative
WOMAC Pain Mean± SD P-value	15.67±1.92	10.22±1.78 P<0.05	15.67±1.92	7.75±1.81 P<0.05	10.22±1.78	7.75±1.81 P<0.05
WOMAC Stiffness Mean± SD P-value	5.33±0.88	4.99±0.78 P>0.05	5.33±0.88	4.75±0.86 P>0.05	4.99±0.78	4.75±0.86 P>0.05
WOMAC Function Mean± SD P-value	51.25±6.03	42.49±5.12 P<0.05	51.25±6.03	36.08±6.55 P<0.05	42.49±5.12	36.08±6.55 P<0.05
Quadriceps Strength Mean± SD P-value	16.86±5.25	19.75±5.34 P<0.05	16.86±5.25	15.24±5.16 P>0.05	19.75±5.34	15.24±5.16 P<0.05
Hamstring Strength Mean± SD P-value	11.13±3.54	13.41±3.7 P<0.05	11.13±3.54	11.65±3.61 P>0.05	13.41±3.7	11.65±3.61 P<0.05

Results of the control group

Result of WOMAC Pain scale:

There were a significant difference 6-weeks postoperative compared with baseline assessment (P<0.05), as shown in table 3.

Results of WOMAC Stiffness scale:

There were a non significant differences in stiffness scale 6-weeks postoperative compared with baseline assessment (P>0.05), as shown in table 3.

Results of WOMAC Function scale:

There were a significant difference 6-weeks postoperative compared with baseline assessment (P<0.05), as shown in table 3.

Results of muscle strength:

There were a significant difference 6-weeks postoperative compared with baseline assessment (P<0.05), as shown in table 3.

There were a non significant differences in hamstring strength 6-weeks postoperative compared with baseline assessment (P>0.05), as shown in table 3.

Table (3): The means and standard deviations values for WOMAC score and muscle strength in the control group.

	Baseline Mean ±SD	Postoperative Mean ±SD	P-value
WOMAC Pain	15.54±1.89	7.23±1.92	P<0.05*
WOMAC Stiffness	5.15±1.06	5.15±0.68	P>0.05
WOMAC Function	52.54±5.3	34.48±5.69	P<0.05*
Quadriceps Strength	16.03±4.82	14.51±4.62	P<0.05*
Hamstring Strength	10.99±2.79	10.03±2.63	P>0.05

*= Significant

Comparison between the two groups:

A comparison between the two groups' baseline measurements for WOMAC scale and muscle strength did not show any significant difference between them (P>0.05) which indicated that the two groups were homogenous.

A Comparison between the two groups postoperative revealed no statistically significant difference between WOMAC score and muscle strength in the two groups(P>0.05). Although there was no statistical difference between the two groups, the comparison between the percentages of change between groups showed that the experimental group had less quadriceps muscle power decrease postoperatively than the control group.

DISCUSSION

This study was conducted to investigate the effect of a 4 weeks preoperative exercises on pain and functional recovery among patients undergoing total knee arthroplasty.

The data presented showed that patients completed the 4 weeks preoperative intervention responded positively to the exercise program through increased lower extremity muscle strength prior to surgery. This improvement in function and strength did not continue post operatively. One possible explanation for this finding is that patients with chronic disease are resistant to a few weeks of physical therapy, as a result of surgery which deconditions the function of the extremity with loss of any preoperative improvement[5].The effect of operation, suggest that patients lose approximately half of their preoperative quadriceps strength in the first month after surgery, that it overshadows the relatively smaller benefit of preoperative exercise[28]. Saudi patients tend to lose their muscle strength in their fourth decade compared to the Western societies[2].

While the reason for quadriceps weakness is not well understood, it has been suggested that a combination of muscle atrophy and neuromuscular activation deficits contribute to residual strength impairments. Pain associated with surgical trauma evokes failure of voluntary muscle activation[20]. The loss of strength was largely explained by a combination of failure of voluntary muscle activation and atrophy, which may explain the temporary decrease in function score after surgery for the exercise group in the present study[18].

Prior to TKA, preoperative quadriceps strength is a strong predictor of functional performance 1 year after surgery[19]. Individuals with more extensive signs of O.A have more quadriceps weakness, and if quadriceps weakness could be addressed prior to TKA surgery, then perhaps patients might experience a better overall functional level[27]. Improvement in self-report physical function is often most strongly associated with improvements in pain[29].

The hamstring muscle strength was not commonly addressed in the literature as the quadriceps although hamstring strength deficits have been reported after TKA surgery by several studies[12,26]. Hamstring weakness after TKA was hypothesized to be as a result of surgical technique, the design and resultant biomechanics of total knee prostheses. The focus on the quadriceps is due to the association of the quadriceps to normal functional activities such as walking and stair climbing[26].

A growing number of studies[9,12,13,17], suggest that poor preoperative functional status is associated with poorer outcome in terms of both function and pain after total joint arthroplasty. This has an important implication particularly for women who, in a number of

studies, have been shown to have more disability at the time of surgery and a willingness to accept a greater decline in function before considering surgery[11,16].

The results of the present study did not reveal any significant difference between the experimental group and the control group, which in consistent with the previous studies[10,22],conducted to investigate the effect of preoperative exercises on TKA patients.

It could be concluded that Although there was no significant effect of the preoperative exercises on improving outcome in patients undergoing TKA, there was a modest promising effect of exercise to minimize the postoperative muscle weakness.

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الملخص العربي

تأهيل ما قبل الجراحة لمرضى الاستبدال الكامل لمفصل الركبة

تهدف هذه الدراسة إلى اختبار أثر تأهيل ما قبل جراحة الاستبدال الكامل لمفصل الركبة مقارنة بالإجراءات المعتادة على الألم والشفاء الوظيفي للمرضى المهيئين على قائمة جراحة الاستبدال الكامل لمفصل الركبة . أجريت الدراسة على ثلاثين مريضا من الجنسين تتراوح أعمارهم من 40 إلى 75عاما مقيدين على جدول جراحة الاستبدال الكامل لمفصل الركبة ، قسموا إلى مجموعتين : المجموعة التجريبية والتي قامت بإجراء التمرينات لمدة 4 أسابيع قبل إجراء الجراحة والمجموعة الضابطة والتي لم تقم بإجراء التمرينات قبل الجراحة. تم تقييم هؤلاء المرضى باستخدام مقياس الشفاء الوظيفي باستخدام استبيان وماك (WOMAC) ومقياس قوة العضلات اليدوي وتمت عملية التقييم في البداية وقبل الجراحة مباشرة و 6 أسابيع بعد الجراحة . أظهرت نتائج الدراسة عدم وجود فرق ذو دلالة إحصائية بين المجموعتين على الرغم من أن المجموعة التجريبية (مجموعة التمارين قبل الجراحة) كان لديها معدل انخفاض في القوة العضلية اقل من المجموعة الضابطة . خلصت الدراسة إلى انه وعلى الرغم من عدم وجود أي اختلاف ذو دلالة إحصائية بين المجموعتين إلا انه قد يكون هناك اثر كامن للتمارين ما قبل الجراحة يعد بنتائج أفضل لو طبقت التمارين في مرحلة مبكرة قبل إجراء الجراحة .