Effect of a 6-week rehabilitation program on gait parameters after total knee arthroplasty

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ABSTRACT

الأهداف: تقييم التغيرات التي تطرأ على المشي (سرعة المشي، عدد الخطوات في الدقيقة، وطول الخطوة) بعد عملية الاستبدال الكلي لمفصل الركبة.

الطريقة: أُجريت هذه الدراسة الاستطلاعية التي تقيم التغيرات قبل وبعد العملية الجراحية في مستشفى الملك فيصل التخصصي ومركز الأبحاث، الرياض، المملكة العربية السعودية وذلك خلال الفترة من مارس 2009م إلى فبراير 2010م. اشترك في الدراسة 15 مريضاً تعين خضوعهم لعملية استبدال كلي للمفصل في أحد الركبتين، ومن ثم دخلوا في برنامج استمر لمدة 6 أسابيع من العلاج التأهيلي بعد العملية الجراحية. ولقد تم تحليل شدة الألم والمتغيرات التي تطرأ على المشية قبل العملية وبعد العملية بستة أسابيع وذلك باستخدام ميزان المؤشر المستمر المرئي (Visual Analogue Scale)، وكذلك بواسطة طريقة طبع القدمين الاعتيادية.

النتائج: أظهرت النتائج الإحصائية تحسناً في شدة الألم، غير أن هناك انخفاض ملحوظ في سرعة المشي، وعدد الخطوات في الدقيقة، وطول الخطوة بعد 6 أسابيع من العلاج التأهيلي وذلك بالمقارنة مع النتائج التي ظهرت قبل العملية.

خاتمة: تشير الدراسة بأن البرنامج التأهيلي الذي يستمر لمدة 6 أسابيع فقط بعد العملية غير كافي لاستعادة قدرات المشي التي كان يمتلكها المرضى قبل إجراء عملية الاستبدال الكلي لمفصل الركبة، ولذلك يجب زيادة مدة العلاج التأهيلي بعد العملية الجراحية لتحسين قدرات المريض على المشي.

Objectives: To investigate early changes in gait parameters following total knee arthroplasty (TKA).

Methods: Fifteen patients scheduled to undergo unilateral TKA at King Faisal Specialist Hospital and Research Centre (KFSHRC), Riyadh, Saudi Arabia, between March 2009 and February 2010, were included in the study. This study was a prospective pretest-posttest experimental design; all patients underwent unilateral TKA, and were subjected to a 6-week standard postoperative rehabilitation program. Pain intensity and gait variables were evaluated before surgery and 6-weeks postoperatively using the Visual Analogue Scale and simple footprint method.

Results: Statistical analysis showed improvement in pain intensity and reduction in gait velocity, cadence, and stride length following the 6-week postoperative exercise intervention compared with preoperatively.

Conclusion: A 6-week postoperative exercise program is not a long enough time-period to restore walking abilities to their pre-surgery values in patients undergoing TKA. A longer period of rehabilitation is needed to improve the quality of the patient's gait.

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Total knee arthroplasty (TKA) is a widely used intervention in the management of knee osteoarthritis (OA).[1] Patients with TKA exhibit deficits in functional tasks, which is a common finding after TKA.[2] Reduced pain and improved functional performance are the main goals for surgical interventions in such patients.[3] Clinical examination of patients with knee arthroplasty can be based on their functional walking ability.[4] Improved walking ability in those patients is dependent on improvement of their functional performance.[5] Walking is one of the important

functional activities performed in patients with OA.[6] Walking as a primary movement concern can be used as one of the principals' locomotor activities.[3] Walking speed is a quick, easy test to administer, and is a reliable, valid, and sensitive measure,[7] it is often included in clinical research studies.[8] Walking speed can be used as a parameter for intervention effectiveness.[9] Analysis of gait has become an important part in evaluating many disorders. Gait analysis needs comprehensive assessment, which may not be appropriate in those disabled patients who need assistance during evaluation.[10] Compared with such sophisticated methods, the footprint method is easy to apply, inexpensive, and less time consuming.[10,11] The aim of this study is to investigate the early changes in gait parameters following TKA.

Methods. ***Subjects.*** Fifteen patients (6 men and 9 women) scheduled to undergo unilateral TKA at King Faisal Specialist Hospital and Research Centre (KFSHRC) in Riyadh, Saudi Arabia, between March 2009 and February 2010, were included in this prospective pretest-posttest experimental study. Their age ranged from 40-75 years, with a mean age of 61.92 ± 6.44 years. To be included in the study, patients should have no flexion contracture in the knee joint and should be able to walk at least 5 minutes (with or without aids) prior to surgery. The exclusion criteria included patients who have severe pain and deformity in other joints that may interfere with physical activities and/or require active management, patients who are not fit for surgery, or wheelchair bound or bed ridden, patients with any neuromuscular disease, and patients who had previous TKA. After reviewing the medical records, demographic data including age, body weight, height, and BMI were collected. The experimental procedure was revised and approved by the research committee of Physical Therapy and Rehabilitation Sciences Department at the College of Applied Medical Sciences, Al-Kharj University, Saudi Arabia. All patients were collected and evaluated at KFSHRC. The purpose and procedures of the study were explained, and all patients gave informed prior consent prior to evaluation and treatment procedures, and were free to withdraw from the study at any time. All patients were operated on by the same 2 surgeons at KFSHRC using the same surgical technique, and received the same type of knee prosthesis.

Procedures. All patients were evaluated for pain intensity and gait parameters (walking velocity, cadence, and stride length) before surgery and 6-weeks postoperatively. Pain was recorded on a 10 cm visual analogue scale (VAS), where 0 indicated no pain, and 10 indicated extremely intense pain. The patient completed the scale by marking on the VAS at a point where he/she believed it represents the amount of pain. Walking velocity was tested by asking the subject to walk 25 meters on a level surface using his normal pace. Four lines are drawn on the floor; the lines were labeled with numbers 1 to 4. The distance between the first and the second line was 2 meters, between the second and third line was 25 meters, and finally between the third and fourth lines was 2 meters. The patient was asked to walk in his normal and comfortable pace, with his (or her) usual walking aids and footwear, from line one to line 4. A simple hand held digital Casio™ stopwatch was started as soon as the patient's foot crossed line 2 and was stopped as soon as the patient's foot crossed line 3. Walking velocity (meter per second) was calculated using the mathematical equation: Speed = Distance/Time, and the speed was expressed with m/sec. The stride lengths (distance between the heel strike of one foot and the next heel strike of the same foot) and cadence (the number of steps per minute) were measured using the simple footprint method.[10,11] A 5 x 0.75 meter sheet of smooth tracing white paper was taped on the floor; each patient was seated on an armrest chair at one end of the paper sheet. Another small sheet dusted with talc powder was placed under the patient's feet, where patients were asked to dust both feet with the powder. Then patient was asked to stand up and walk with normal and comfortable speed on the paper sheet. Measurements from the middle 3 meters of the paper were taken only to ensure the patient's normal pattern of walking, and avoid artefacts from starting or stopping. The feet imprints were marked by a pen, and a ruler at the heel and toes points.

Treatment procedures. All patients underwent a 6-week postoperative standard hospital inpatient and outpatient clinic rehabilitation program. The rehabilitation program consisted of strengthening exercises for the upper and lower extremities, and mobilizing exercises to improve knee range of motion. This program included initial warming-up exercises for the upper and lower limbs using an ergometer combined with breathing exercises using incentive spirometry. Initial stretching exercises for the 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 6-week period.

Data analysis. Data processing were carried out using the Statistical Package for Social Sciences (SPSS Inc, Chicago, IL, USA) version 10. The mean and standard deviations of the pre and postoperative variables were calculated. Test-retest differences were evaluated by paired t-test, and alpha-values were accepted at the 0.05 level of probability.

Results. The subject characteristic data including age, height, weight, and BMI are summarized in **Table 1**. **Figure 1** shows the significant decrease in the pre and post-operative VAS pain intensity scores. **Figure 2** shows a significant decrease in the pre and post-operative mean gait velocity. **Figure 3** shows the significant decrease in the pre and post-operative mean cadence values, and **Figure 4** shows the significant decrease in the pre and post-operative mean stride length values.

Table 1- Characteristics of the study participants.

Patient's characteristics	Mean ± standard deviation
Age, years	61.92 ± 6.44
Height, cm	157.3 ± 9.26
Weight, kg	85.67 ± 24.45
Body mass index, kg/cm²	34.23 ± 8.05
Duration of symptoms, years	10.31 ± 4.21

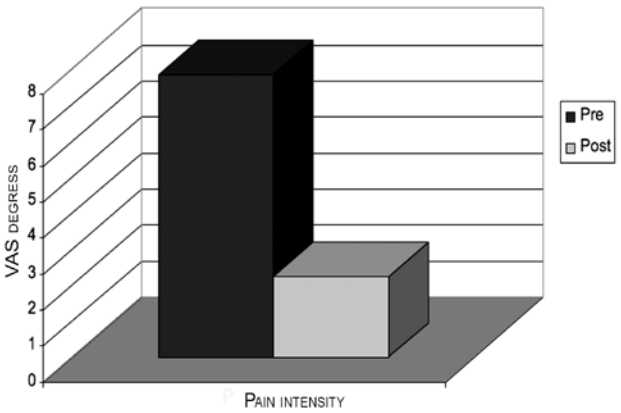

Figure 1 - The mean values of pain intensity before surgery and postoperative. VAS - visual analogue score

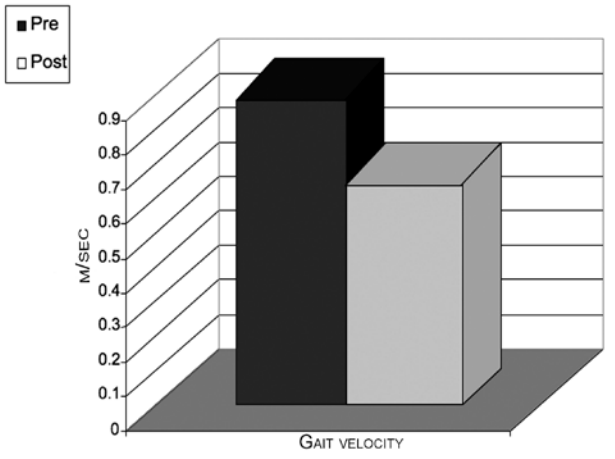

Figure 2 - The mean values of gait velocity (m/sec) before surgery and postoperative.

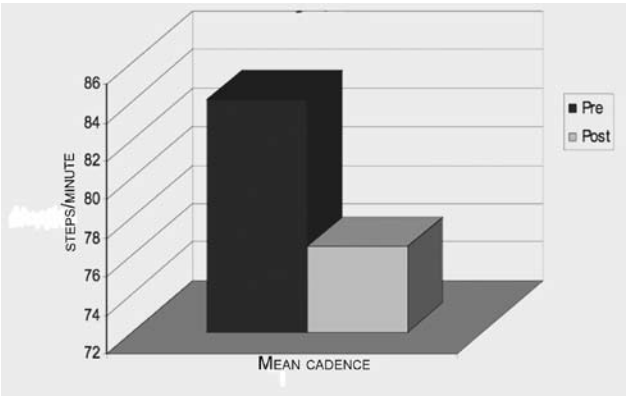

Figure 3 - The mean cadence (steps/min) before surgery and postoperative.

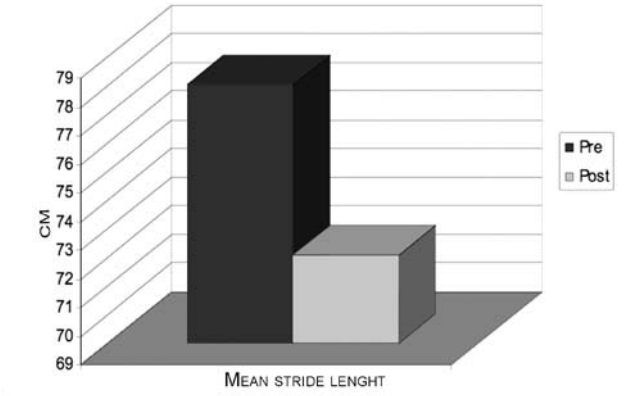

Figure 4 - The mean stride length (cm) before surgery and postoperative.

Discussion. The aim of the study was to investigate the early changes in walking abilities in patients after TKA compared with before surgery. Walking is a common functional activity of daily living. This study provides meaningful information on postoperatively gait changes, which should be helpful for the optimal management and evaluation of treatment outcomes. In this study, walking velocity, cadence, step length, and pain intensity changed significantly compared with before surgery. These findings are similar to those found in previous studies.[12,13] Patients with knee OA demonstrated a lower walking speed, lower cadence, shorter step length, and shorter single stance phase of the involved leg.[14,15] However, the early postoperative period is often characterized by limited function.[16] This reduction in spatio-temporal parameters could be attributed to the adaptive mechanism to reduce pain. The TKA patients do not try to increase speed, being more concerned with avoiding pain and improving stability.[17] Patients with TKA appear cautious and are more concerned with gait quality than a fast pace. Both pain and necessity to control knee stability account for this walking reduction.[11] Assessment of gait before

and after TKA revealed certain gait characteristics for those patients. Many patients treated by TKA cannot achieve normal joint function over time. In most cases, gait has limited flexion range both during the stance and the swing phase following TKA. It was concluded that, TKA gait pattern was characterized by slow speed and reduced stride length.[18] It was suggested that poor preoperative functional status is associated with poorer outcome in terms of function and pain.[19] Development of abnormal gait patterns after TKA may be related to the predictable pattern of further deterioration of other lower extremity joints.[20] This deterioration in other joints could affect patient's gait, rather than the treated part.

The results of the present study showed a significantly slower gait 6-weeks postoperatively compared with their preoperative scores. This finding is consistent with previous work carried out at different short postoperative time periods.[17] These results could be explained by the early time of assessment when patients are still recovering from surgery, and its effect on muscle strength and range of motion. The slow gait, short involved leg stride length, and lesser cadence could be attributed to the reduction of muscle strength of both the quadriceps and hamstrings muscles post operatively, as well as the reduction of knee range of motion, especially in the knee flexion range.[21]

The current study used a simple, inexpensive, and practical method of gait analysis (footprints method) and the assessment time was in the early stages of recovery. The results are consistent with previous studies,[3,9,17,20] which utilized more sophisticated gait analysis laboratories at different time periods postoperatively.

This study is limited by the small size of patients included, and also the short period of rehabilitation intervention. Future study should include a larger population and longer follow up period. This study used a single pre-post analysis design in which the pre-operative data were used as the control to evaluate the effect of rehabilitation program, as there was no control group for comparison of the experimental data with normal values.

In conclusion, a 6-week postoperatively rehabilitation for patients that underwent TKA is too short of a period to predict improvement in gait parameters, and it will be interesting to assess gait parameters after a longer time postoperatively.

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