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Does intervention improve the outcomes of patients after total knee replacement surgery?

Hassan Abbass Reslan (RN, MSN) (Staff Nurse)[a], Sawsan M. Moustafa (RN, PhD) (Assistant Professor)[b], Said Saghieh (MD) (Clinical Associate Professor of Surgery)[c], Eman S. Sharara (MPH) (Research Assistant)[d], Lina Kurdahi Badr (RN PhD, FAAN) (Professor School of Nursing)[e,*]

[a] American University of Beirut Medical Center, Beirut, Lebanon
[b] Beirut Arab University, Beirut, Lebanon
[c] Clinical Associate Professor of Surgery, School of Medicine, American University of Beirut, Lebanon
[d] Research Assistant, School of Public Health, American University of Beirut, Lebanon
[e] Professor School of Nursing, Azusa Pacific University, 701 West Foothill Blv, Azusa, 91701, California, USA

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ABSTRACT

Objective: To assess the effect of a one to one intervention by a nurse on the outcomes of patients undergoing Total Knee Replacement (TNR) surgery.
Methods: A quasi-experimental design was used with 60 participants, half of which received a one to one intervention including education and exercise training by a nurse prior to surgery. Follow up was at two and four weeks post-surgery to assess pain, knee function using the Hospital for Special Surgery (HSS) Knee Rating Sheet and activities of daily living measured on the Lower Extremity Functional Scale (LEFS). ANOVA tests were used to compare significant differences between groups.
Results: The intervention group had less pain at two and four weeks, $p = 0.00$, and better knee function at four weeks, $p = 0.026$. Activities of daily living were better for the intervention group at both two and four weeks, $p = 0.002$ and 0.048.
Conclusion: The one to one intervention provided by a nurse before TKR surgery was instrumental in decreasing pain, improving knee function and enhancing activities of daily living.

Introduction

Total knee replacement (TKR), or knee arthroplasty, is a common surgical procedure to replace the weight-bearing surfaces of the knee joint for individuals with advanced osteoarthritis, rheumatoid arthritis, and post traumatic arthritis (Ferket et al., 2017). TKR is often an option when conservative treatments have been exhausted and patients have severe pain and functional disabilities (French et al., 2011; Page et al., 2011). Based on the AHRQ data, in 2009 there were over 600,000 TKRs in the US at a toal cost of 28.5 billion (HCUPnet, 2011). Similar findings are reported from Europe and Asia where the rates of TKRs have doubled or tripled in the past few decades with substantial health care costs (Hitzl et al., 2018; Lin et al., 2018). What is worrisome is the fact that, since 1999, there has been an increase of 134% in TKR for individuals who are eighteen years of age or older (Losina et al., 2012; Singh et al., 2010). With new prosthetic materials and advanced surgical skills, the number of primary TKRs will continue to rise (Ferket et al., 2017) along with complications which often do not resolve with time. These complications include, but are not restricted to, deep vein thrombosis, periprosthetic fractures, stiffness of the joint, low levels of physical activity and infection (Beswick et al., 2012; Ferket et al., 2017). Some of these complications may be prevented with patient education and physical training (Piva et al., 2017).

Benefits of preoperative patient education and rehabilitation include: enabling patients to assume better responsibility for their own health care, improving functional status, decreasing pain, maximizing independence and reducing complications after surgery (Chen et al., 2014; Kearney et al., 2011; Piva et al., 2010, 2017). A large study of 904 patients who underwent TKR found that patient participation in a preoperative educational program decreased the length of hospital stay and significantly reduced overall costs (Tait et al., 2015). Likewise, a study with 472 patients who underwent knee arthroplasty found that

* Corresponding author.
E-mail addresses: hr22@aub.edu.lb (H. Abbass Reslan), s.mohammadyousef@bau.edu.lb (S.M. Moustafa), ss15@aub.edu (S. Saghieh), es52@aub.edu.lb (E.S. Sharara), lbadr@apu.edu (L.K. Badr).

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participants who received a group educational intervention had shorter length of hospital stay, but no differences were noted in terms of post-operative complications (Jones et al., 2011). Five recent systematic reviews that evaluated whether pre-operative physiotherapy and education improved patient outcomes after TKR surgery concluded that, although there may be some short term benefits to patients, there was large heterogeneity among studies with insufficient evidence to support or refute the efficacy of such interventions (Artz et al., 2015; Aydin et al., 2015; Jordan et al., 2014; McDonald et al., 2014; Peer et al., 2017). In addition, most studies published to-date were conducted in Western countries where preoperative education and internet information are often available for patients undergoing surgery (van Eck et al., 2018). Such resources are not accessible or provided in low and middle income countries with limited resources. Although internet information may be accessible, the information may not be current, evidence based or sufficient (Schairer et al., 2017). In recent studies in Spain of 263 patients (Cano-Plans et al., 2018), as well as one conducted in seven European countries with 290 patients (Ingadottir et al., 2014) undergoing knee surgery, the authors concluded that patients did not have their knowledge expectations met and the education was not carried out according to their individual needs.

The situation in low and middle income countries may be different, as standards of care vary and patients often receive minimal education or preparation before surgery. Furthermore, patient education may have different effects in different cultures. While in several high income countries patients are well versed in obtaining medical information from the web (Sculco et al., 2017) and may not benefit from information provided to them by health professionals, in low and middle income countries patients often rely solely on health providers for medical information (Mesch, 2016). There is a dearth of publications on the effect of education on patient outcomes in the Middle East. One earlier study, in Lebanon, found that pre-operative one to one patient education by a nurse prior to open-heart surgery had little effect on patient anxiety post-surgery (Deyirmenjian et al., 2006). Another study, in Iran, with 59 patients on hemodialysis, showed that a one to one educational intervention had a significant effect on the patients' self-concept, but did not have any effect on their independence (Afrasiabifar et al., 2013). An educational group intervention for parents of children with sickle cell disease found a significant increase in knowledge and management of the disease as well as a decrease in the number of hospitalizations (Shahine et al., 2015). Patient education on a one to one basis for patients with uncontrolled diabetes in Turkey significantly decreased their HbA1c levels but had no effect on their cholesterol and triglyceride levels (Cander et al., 2014).

Based on these incongruent findings, the lack of studies in the Middle East and the importance of patient education for patients undergoing TKR surgery, the purpose of this study was to identify the effect of a one to one intervention by a nurse on the functional outcomes and activities of daily living for patients undergoing total knee replacement (TKR) surgery at a University Medical Center in Lebanon.

Hypothesis. Patients who receive an intervention preoperatively including education and exercise training will have better knee function and more independent activities of daily living at two and four weeks after surgery than patients who do not receive the intervention.

Methods

Design

A quasi-experimental pre and post design was used with consequential assignment to each group to avoid contamination. The first group (group I) was the control group and was recruited between January 2016 and July 2016; the second group (group II) was the intervention group and was recruited between August 2016 and January 2017. This was done to avoid discussion among patients in both groups who often wait for over 1 h to see their surgeon.

Setting

The study was conducted in the out-patient orthopaedic clinic in Lebanon, a small middle-income country in the Eastern Mediterranean, with an estimated population of 4 million people (Hajj et al., 2016). The hospital is a tertiary referral medical center with 420 beds. It provides inpatient and outpatient services to the people of Lebanon and the region, and is Joint Commission International (JCI) accredited and Magnet designated [Magnet status is an award given by the American Nurses' Credentialing Center (ANCC, 2011) to hospitals which meet certain standards that measure the strength and quality of the nursing care]. The hospital provides all kinds of medical, surgical and specialized services and admits around 30,000 patients a year (Hajj et al., 2016).

Subjects

The sample included 60 patients undergoing total knee replacement by one surgeon, who were between the ages of 40–70 years, with no other chronic illness that may affect their functional outcomes such as end stage kidney disease or diabetes, rheumatoid arthritis, septic arthritis, or a previous fracture of the lower limbs (Miric et al., 2014). Although recruiting from one surgeon limits generalizability, participants were recruited from a single surgeon in an attempt to minimize the potential confounding effects of varying surgical techniques and care protocols. Patients interested in participating in the study signed a consent form, then were divided into two groups sequentially: the first enrolled group was the control group and the second group was the intervention group.

Group I (control group): included 30 patients who received the standard hospital care for TKR which included a brief discussion with the surgeon about the surgery, and fitting with a cane, crutches or a walker by the physical therapist.
Group II (Intervention group): included 30 patients who received, in addition to the standard care, individualized teaching about the surgery, and exercise training by one nurse who has a master's degree in nursing and works in the orthopedic clinic.

Instruments

Two scales were used to assess participants before and after surgery: 1) the Hospital for Special Surgery Knee Rating Sheet (HSS Knee Rating Sheet) (Insall 1976) and; 2) the Arabic version of the Lower Extremity Functional Scale (LEFS) (Alnahdi et al., 2016). The HSS is a standardized, reliable and valid instrument used after TKR to assess the functional status of patients undergoing total knee replacement surgery in the preoperative and postoperative period. The HSS has been used extensively, is easy to apply, and quick to record (Narin et al., 2014; Singh et al., 2013; Słupik and Białoszewski, 2009). The HSS includes 6 subscales:1) pain while walking (30 points); 2) knee function while walking, climbing stairs, and transfer (22 points); 3) range of motion (ROM) of the knee (18 points); 4) strength of quadriceps muscle (10 points); 5) presence of flexion deformity (10 points); and 6) knee Instability (10 points). A total score is obtained on each subscale, with deductions made for items such as the use of a cane or crutch or varus/valgus deformity. Scores on the HSS range from 0 to 100 with higher scores reflecting better outcomes (Insall et al., 1976).

The LEFS is a patient reported scale to assess symptoms and functional limitations experienced during activities of daily living by individuals with musculoskeletal disorders such as walking around the house, bathing, and rolling in bed (Alnahdi et al., 2016). It has been used in both clinical practice and for research purposes and has 20

items each scored on a 0–4 Likert scale with an overall score of 80; with higher scores indicating better functional ability. The LEFS has been translated into several languages including Arabic and has shown excellent internal consistency, test–retest reliability, and validity (Alnahdi et al., 2016; Binkley et al., 1999; Mehta et al., 2016).

Patient characteristics. Age, gender, marital status, level of education and working status and availability of support were assessed at baseline.

Procedure

Ethical approval was obtained from the Institutional Review Board (IRB) of the University. An educational package was prepared by the nurse (HR) using Powerpoint format based on current evidence in the literature (Moffet et al., 2004; Piva et al., 2010) with the expert opinions of nurses and orthopedic surgeons at the center. The Powerpoint presentation was pilot tested on 6 patients for feasibility, clarity, and applicability. It included information about osteoarthritis, the importance of physical activity, nutrition, pain management, preoperative preparation, and postoperative management. After the Powerpoint presentation, the patient was instructed in the use of a cane, crutches or a walker, while walking or using the stairs (up and down). The patient was asked to practice weight bearing exercises, such as stretching of knee extensors, knee flexors, ankle plantar flexors, leg abduction, and marching on the spot. For activities of daily living, patients in the intervention group were taught how to get into and out of bed, and how to use the toilet, chair, the shower or tub. Participants practiced peforming these exercises before surgery and instructed to perform them at home as often as possible. The education and exercise session lasted 30–40 min for each patient. All educational materials and interventions provided were offered with a family member present as patients in Lebanon are dependent on them for support and care and in making choices for treatment (Dumit et al., 2015). All patients received a neuromuscular, physical and pain assessment by their physician before the surgery. After surgery, outpatient physical rehabilitation was provided as needed to both groups.

For the outcome measures the HSS and the LEFS were obtained for each patient individually the day before surgery using observation, inspection and patient self-reporting by a nurse researcher blinded to the subject's group assignment. The assessments were repeated at two and four weeks post-operatively when patients returned for their follow up visits. There were no patients lost to follow up.

Data analysis

SPSS version 24 for windows (Statistical Package for the Social Sciences) was used for data analysis. A sample size of 30 subjects per group was based on a previous study (Fuchs et al., 2005) with a 4-point mean significant difference (SD ± 4.48) between groups on the range of motion subscale on the HSS scale with an 80% power and an alpha of $\alpha < 0.05$). Descriptive statistical analyses were first conducted for both study and control groups to assess similarity or differences between groups. The mean and standard deviation on each of the 6 subscales, as well as the total score, were derived for the three time-points (pre-surgery, and on the second and fourth weeks after surgery), for both groups based on the scoring instructions of the instrument. Differences between groups at the three time points were computed using one way ANOVAs.

Results

Patient characteristics

The characteristics of patients in the intervention and control groups are shown in Table 1. Both groups were similar in terms of age, gender, marital status, educational level and working status. The majority were between 50 and 60 years old, 36 (60%) were females, 47 (78%) were married, 49 (82%) had a high school or university education and 39 (65%) were retired or not working. All participants indicated that they had support at home from a family member or hired help.

Table 1
Characteristics of participants in the study and control groups.

Characteristics	Intervention Group		Control Group	
	N = 30	%	N = 30	%
Age				
< 50 years	1	3.3	1	3.33
50–60 years	16	53.4	18	60.00
61–70 years	13	43.3	11	36.7
Gender				
Males	11	36.7	13	43.3
Females	19	63.3	17	56.7
Marital Status				
Single	1	3.3	1	3.33
Married	22	73.3	25	83.3
Widowed	7	23.4	4	13.4
Educational Level				
None	6	20	5	16.7
High School	15	50	18	60
University	9	30	7	23.3
Working	9	30	12	40
Retired/home	21	70	18	60

Differences between groups on the HSS 6 subscales

Since there were no differences between groups on the baseline socio-demographic variables, there was no need to statistically control for these variables between groups at two and four weeks (see Table 2). Patients in both groups expressed severe pain before the surgery with no patient expressing mild or no pain. Pain at two and four weeks after surgery was significantly different between groups with the intervention group expressing less pain than the control group at two weeks, 19.51 ± 5.33 vs 17.20 ± 6.54, ($F = (1/58) = 8.91$, $p = 0.004$). At four weeks, the intervention group had a mean pain score of 22.83 ± 4.78 while the control group had a mean of 19.18 ± 5.14, ($F (1/58) = 11.95$, $p = 0.001$). There was no difference in knee function between groups before the surgery or at two weeks after surgery. However, at four weeks the intervention group had a mean score of 15.73 ± 3.49 vs 13.92 ± 3.35, ($F (1/58) = 5.21$, $p = 0.026$). There were no significant differences between groups in terms of range of motion before the operation or at two and four weeks. Similarly, no significant differences were found in quadriceps strength pre-operation or at four weeks, but at 2 weeks the intervention group had better scores of 8.67 ± 3.40 vs 7.53 ± 2.16, ($F (1/58) = 4.49$, $p = 0.038$). There was no significant difference between both groups in flexion deformity before surgery, but a significant difference was noted at both two and four weeks. At two weeks the intervention group had a mean of 8.67 ± 2.40 whereas the control group had a mean of 7.73 ± 2.33, ($F (1/58) = 4.05$, $p = 0.049$) and at four weeks the intervention group had a mean of 10.02 ± 1.21 while the control group has a mean of 8.47 ± 1.93, ($F (1/58), = 7.77$, $p = 0.007$). Knee instability was significantly improved for the intervention group at two weeks, with a mean of 9.73 ± 1.68 vs 8.93 ± 2.02, ($F (1/58) = 5.63$, $p = 0.021$) and at four weeks a mean of 9.89 ± 3.41 vs 8.27 ± 2.98, ($F (1/58) = 4.04$, $p = 0.049$). The total score on the HSS between groups was not different between groups before surgery but at two weeks it was 87.99 ± 14.55 for the intervention group vs 79.23 ± 15.54 for the control group, ($F (1/58) = 5.04$, $p = 0.029$), and at four weeks it was 92.45 ± 13.45 for the intervention group vs 86.98 ± 21.22 for the control group, ($F (1/58) = 5.21$, $p = 0.026$).

Table 2
HSS scores before and after surgery.

Subscales of the HSS	Intervention group N = 30 Mean ± SD	Control Group N = 30 Mean ± SD	F value	P Value
Pain				
Before surgery	17.83 ± 3.45	16.83 ± 2.25		NS
Two weeks after surgery	19.51 ± 5.33	17.20 ± 6.54	8.91	0.004
Four weeks after surgery	22.83 ± 4.78	19.18 ± 5.14	11.95	0.001
Knee function				
Before surgery	9.80 ± 1.92	9.73 ± 1.87		NS
Two weeks after surgery	12.67 ± 4.76	13.87 ± 3.51		NS
Four weeks after surgery	15.73 ± 3.49	13.92 ± 3.35	5.21	0.026
Range of Motion				
Before surgery	14.47 ± 3.51	13.43 ± 3.66		NS
Two weeks after surgery	16.47 ± 2.63	15.12 ± 3.11		NS
Four weeks after surgery	17.04 ± 2.55	16.53 ± 4.20		NS
Quadriceps Muscle strength				
Before surgery	6.33 ± 2.45	6.83 ± 2.25		NS
Two weeks after surgery	8.67 ± 3.40	7.53 ± 2.16	4.68	NS
Four weeks after surgery	9.13 ± 3.81	8.47 ± 2.93		NS
Flexion deformity				
Before surgery	6.90 ± 1.47	6.20 ± 1.50		NS
Two weeks after surgery	8.67 ± 2.40	7.73 ± 2.33	4.05	0.049
Four weeks after surgery	10.02 ± 1.21	8.47 ± 1.93	7.77	0.007
Instability				
Before surgery	4.63 ± 0.77	5.90 ± 0.71		NS
Two weeks after surgery	9.73 ± 1.68	8.93 ± 2.02	5.63	0.021
Four weeks after surgery	9.89 ± 3.41	8.27 ± 2.89	4.04	0.049
Total score				
Before surgery	78.22 ± 13.41	77.77 ± 12.41		NS
Two weeks after surgery	87.99 ± 14.55	79.23 ± 15.54	5.04	0.029
Four weeks after surgery	92.45 ± 13.45	86.98 ± 21.22	5.21	0.026

Lower Extremity Functional Scale (LEFS) scores before and after surgery

The LEFS scores before surgery were similar between groups. However, the intervention group had higher scores at both two and four weeks. The intervention group had a mean of 56.17 ± 13.22 vs 44.37 ± 14.89, for the control group, (F (1/58) = 11.03, $p = 0.002$. At four weeks the total score was 60.35 ± 11.22 for the intervention group vs 53.83 ± 12.98, in the control group, F (1/58) = 4.07, $p = 0.048$ (see Table 3).

Discussion

The aim of this study was to assess the effects of a one to one intervention by a nurse on the knee function and activities of daily living in patients after TKR in a middle income country. Although, studies have found incongruent results in terms of education and/or exercise training in improving the outcomes of patients after TKR (Peer et al., 2017; McDonald et al., 2014), this study reports positive outcomes. A recent randomized control trial which used a one to one comprehensive behavioral and exercise intervention reported less pain and better physical function at six months post-surgery (Piva et al., 2017). It is plausible that one to one education may provide more significant benefits as individualized attention tailored to each patient may be more effective (Rankinen et al., 2007). It is also possible that the benefits of the intervention were more noticeable in our sample which is younger than reported in previous studies, and more likely to regain knee function after surgery, a finding supported by previous studies (Felts et al., 2010; Leta et al., 2016). It is also plausible that benefits were more noticeable, as little education is provided to patients before surgery at this institution compared to those in high income countries.

In relation to age, the majority of the patients in both groups were between 50 and 60 years, and 37% were between 61 and 70 years which is in accordance with some other studies (Tien et al., 2009; Losina et al., 2012) although different to others where the mean age was higher (Tilbury et al., 2018; Piva et al., 2017). Gender and marital status were also similar to what is reported in earlier studies; whereby more women are represented and most are married (Jordan et al., 2007; Vina et al., 2013). Unlike previous studies, more participants in our study had a high school or a university education which is similar to studies published with participates from this university medical center (Kouatly et al., 2015). Although we did not assess the effect of patient characteristics on recovery after TKR, some studies have reported that women (Rosenberger et al., 2010) and older patients have longer recovery periods (Kennedy et al., 2018), while others have found that no factors were significantly related to activity recovery (Luna et al., 2018). Schooling may also have an effect on pain scores, as noted in a study where patients without a college education had pain scores that were 10 points higher than patients with a college education after Total Knee Arthroplasty (Goodman et al., 2018).

Regarding the assessment of pain, the findings showed that there was no significant difference between the two groups before surgery which is expected for patients undergoing TKR (Beswick et al., 2012) . However, at both two and four weeks post-surgery, the intervention group had less pain. This may be due to the fact that the education included postoperative pain management which may have helped them effectively manage their pain. This finding is in accordance with some

Table 3
Total Lower Extremity Functional Scale (LEFS) Scores before and after surgery at two and four weeks.

	Intervention group N = 30 Mean ± SD	Control Group N = 30Mean ± SD	F value	P Value
Before surgery	38.66 ± 15.23	41.05 ± 14.90		NS
Two weeks after surgery	56.17 ± 13.22	44.37 ± 14.89	11.03	0.002
Four weeks after surgery	60.35 ± 11.22	58.83 ± 12.98	4.071	0.048

earlier studies (Piva et al., 2017; Skou et al., 2014) but not others (Kearney et al., 2011; McDonald et al., 2014). The discrepancy in results could be explained by the method of education used, by the person providing the education and the timing of the education. In this study, one to one teaching provided by an experienced nurse (HR) prior to the surgical procedure may have had more impact than teaching in a group. It is also worth noting that education provided to patients who already have had ample pre-operative education or access to the internet in many high income countries may not result in the same magnitude of beneficial outcomes as when the same education is provided to patients with no or minimal previous education.

In relation to knee function, the results support the benefits of the intervention in improving knee function at both two and four weeks. The better outcome in the intervention group could be attributed to the reinforcement of exercises given on a one to one basis by the nurse before the surgery which is in line with previous studies (Peer et al., 2017; Piva et al., 2017). It has been argued that, for individuals to change their behavior, a high level of engagement is required, which may have been accomplished in this study where each participant had individual attention and coaching by the nurse (Adams, 2010).

With the exception of range of motion, which was not different between groups at both follow up assessments, muscle strength at two weeks, knee instability and flexion deformity at both the second and fourth week after surgery, were significantly improved in the intervention group. This could be attributed to the exercises the participants were couched to perform. This finding is congruent with previous studies that attest to the benefits of exercises to avoid a residual flexion contracture (Dennis et al., 2007; Gstoettner et al., 2011). The lack of improvement in ROM could be attributed to the fact that ROM remains impaired in the majority of patients for over a year (Saleh et al., 2010; Valtonen et al., 2009).

In relation to functions of daily living, most of the patients in the intervention group were independent, while most of the control group needed help at both the second and fourth weeks after surgery. This is supported by previous studies that argue that patient education may be a mediating factor in enhancing the recovery and independence after TKR (Huber et al., 2013; Mograbi et al., 2014).

Limitations

The study is one of a few published that revealed the benefits of a one to one education and exercise program to improve the functional outcomes of patients undergoing TKR. Nevertheless, a few limitations are worth noting. The groups were not randomly assigned, which was done to limit contamination, yet may have resulted in selection bias. All subjects were recruited from a single surgeon's cases and medical center which limits generalizations to other geographic locations. The cost of the hours the nurse spent in educating participants was not calculated, raising concerns about whether the cost was worth the results. We did not assess the relationship between patient characteristics and outcomes which may have had an effect on the outcomes measured. Finally, assessments were made at two and four weeks after surgery, longer follow up would have provided stronger evidence for the efficacy of the intervention. Thus, it is necessary to conduct larger randomized trials to provide more definitive conclusions relating to the finding of this study.

Conclusion

Delivery of a one to one intervention by a nurse that integrates intensive education and exercises before patients undergo TKR in a low income country had a positive effect on their pain levels as well as their knee function and activities of daily living. The role of the nurse in providing education to patients may be effective in improving outcomes after TKR, especially if the education is based on the current evidence, is culturally sensitive, and addresses the personal needs and abilities of individual patients.

Conflicts of interest

The study presented no financial or personal relationships with people or organizations that could inappropriately influence (bias) their work, nor was it funded by organization or grant.

Ethical approval

The Institutional Review Board (IRB) of both Universities approved this study.

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