Effectiveness of physiotherapy intervention with home exercise programme versus patient-directed home exercise programme following a total knee replacement

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INTRODUCTION

Total knee replacements (TKR) are used to replace damaged knee joints, most commonly due to arthritic conditions, with over 70,000 of them being performed a year in the UK.[1]

The current trend for elective surgery is increased throughput and shorter hospital stays.[2,3] In response, within the last two years in south Cumbria, the average length of stay for TKR has reduced from 11 to between five to seven days. It was noted that despite the reduction in length of stay, little had changed regarding physiotherapy care.

The current practice is for no outpatient physiotherapy intervention. The patient is given an exercise and information booklet containing exercises to improve knee range of movement and quadriceps strengthening. They are given verbal advice regarding progression from walking aids and pain/swelling control using ice. Before discharge at an elective surgical unit in Cumbria, the patient is expected to gain 90 degrees knee flexion which is considered to be a functional range of movement.[4] The patient also needs to have progressed onto elbow crutches or sticks, and be able to negotiate up and down stairs safely.

If at the consultant's six weeks postoperative clinic the patient is considered to need any further physiotherapy intervention, they are referred for outpatient physiotherapy.

The timescale of interest in this study is the first six weeks following TKR. A number of studies have been written regarding pre-operative outcomes, and postoperatively at three months, six months and a year, but not within the first six weeks following surgery. This period of time is significant as it is the time period between leaving the ward and the patient's first outpatient follow-up with the consultant.

A holistic approach was taken to give a full overview of recovery. Range of movement (RoM), pain levels, function and quality of life (QoL) were tested alongside the compliance of the patients to complete their home exercise programme (HEP) and to follow instructions. All these outcomes are affected when undergoing a TKR, so needed to be taken into consideration to allow a comprehensive study.

METHOD

The study was a randomised controlled trial. Forty patients were recruited, 20 in each arm of the study. Due to drop outs, the total number that completed the study was 34; 17 in each group between the ages of 29 and 84 years (mean age 68.5; 15 males and 19 females).

The sample was recruited from an elective orthopaedic and surgical centre in Cumbria. All patients were screened medically in the pre-operative clinic by nursing staff prior to the study. All participants had the same procedure.

All patients who fitted the inclusion criteria were identified on admission to the ward from their medical notes, and then approached by the researcher with the patient information sheet. The information sheet was explained verbally by the researcher, any questions answered, and the patient was encouraged to speak to family, friends or any staff on the ward if they needed clarification. The patient was left to decide up to the day of discharge from the ward, then approached to see if they wished to be included in the study or not, and informed consent was acquired if they wished to join the trial.

Inclusion Criteria

- Primary TKR
- Aged 18 years and older
- TKR as a result of rheumatoid arthritis (RA) or osteoarthritis (OA)
- 90 degrees knee flexion prior to discharge
- Using elbow crutches or walking sticks
- Able to safely negotiate stairs

Exclusion Criteria

- Primary TKR due to metastatic disease
- TKR due to trauma without RA or OA
- Required walking aid for unoperated side prior to surgery
- Patients who live too far from hospital to attend outpatients

Ethical approval was gained before the study began. Once the patients had consented, they were randomly allocated into either a control group or intervention group by a computer programme.

The control group followed the current home exercise and advice protocol; they were also given advice about progressing gait (aiming to be unaided by six weeks postoperatively), advised regarding pain control using ice as needed on a daily basis, and were asked to fill in a patient diary. The patient diary was to gain information over five weeks post-discharge regarding pain levels using a visual scale, compliance of the participants with their daily exercises and icing, the length of time until they were able to walk unaided and the length of

time to be able to walk reciprocally up the stairs. They then attended an outpatient physiotherapy appointment at six weeks postoperatively.

The intervention group followed the same HEP as the control group for knee range of movement and quadriceps strength, and were given the same patient diary and QoL questionnaire. However, they were reviewed once weekly, for four weeks, in a 20-minute session by the researcher as an outpatient on the ward. During these sessions, the participant's exercises were checked and progressed by the researcher as necessary. Gait was progressed to independence as able, and advice regarding pain control with ice was reinforced. They too were reviewed at six weeks postoperatively for outcome measurements.

All patients followed the same inpatient protocol during their hospital stay, and were treated by the same three physiotherapists throughout. Standardisation was established before the study commenced to ensure that all exercises in the HEP that were being followed were taught in the same way. It was also ensured that the same advice was given using the HEP as the guideline.

All patients were taught their home exercises as per the 'Returning to activities following knee surgery' booklet before discharge from the ward and the importance of doing these exercises daily as instructed in the booklet was reinforced.

Advice regarding pain control with ice and progression of gait re-education was given to all patients on the ward and reinforced at the point of discharge. It was advised that they should aim to walk short distances unaided by their six-week appointment with the physiotherapist. At discharge (seven days postoperatively), all patients were tested by the researcher using a validated universal goniometer,[5] to ensure that they had 90 degrees knee flexion. They were also assessed that they were safe using either elbow crutches or sticks and that they had safely negotiated the stairs.

The following measurement parameters were tested: knee flexion, functional ability, pain and QoL. Range of movement could be considered to be the principal outcome measure as it is always affected after a TKR. It has been used and appraised by almost all research in this area,[6,7,8] which allowed comparability of the results for the present study with those previously published.

Knee flexion

Knee flexion was tested using a universal goniometer with the neutral zero method in a supine position. A mean of three measures was be used to ensure accuracy. The intratherapist and intertherapist reliability of this method has been previously established, showing that it is highly reliable.[5]

The measurement was taken on the knee joint line on the lateral side of the knee joint, ensuring the axis was central to the joint. The 'arms' of the goniometer followed the line of the femur proximally and the tibia distally to ensure accuracy of measurement.[9]

Function

Functional ability was tested using the six-minute walk test. This is a functional test to ascertain how far a person can walk within a six-minute period. Its reliability and validity is well documented, especially regarding cardiac and pulmonary patients, but is equally valid to use for testing function in a patient following a TKR.[10] It was decided to use the six-minute walk test because it was considered that walking is a useful indicator of function as a single measure.

To perform the six-minute walk test, a 25m length was marked out on the orthopaedic ward corridor. The patients were asked to perform the test independently (without walking aids) if they were able and willing to do so. The patient was told that they could rest at any time during the test and to resume as soon as possible. The length of time of rest was noted. The same stopwatch was used to ensure validity of the test.

When the patient was performing the test, the researcher counted the laps completed. When six minutes had passed, the patient was asked to stop. The point at which they stopped was marked at their heel, and the distance measured from the start line at the beginning of the direction that they were walking in. The total distance was calculated and recorded in metres and centimetres.

Pain

Pain levels were tested using a visual analogue scale (VAS). The validity and reliability of the VAS is well documented by several articles, proven also as a valid tool within the postoperative period.[11] VAS is a line 10cm long, with no markings on it except from a zero (representing no pain) at one end and a ten (representing the worst imaginable pain) at the other.

Diary

A patient diary was given to each participant who entered the study to ascertain: at what point after discharge within the six-week period they were able to walk independently, when they were able to climb stairs reciprocally, how many days a week and how frequently per day they completed their exercises, how painful their knee was at the end of each week using a visual analogue score and how many days per week and how frequently per day they used ice. This diary gave useful information regarding pain levels and also to use as a point of discussion alongside the results of the other outcome measures.

The QoL questionnaire, SF12, was used for both groups at the six-week outcome measure appointment. It was done to gain a valuable insight into the psychological effects of having a TKR, as well as providing more information about the participants' functional ability in terms of activities of daily living.

RESULTS

The purpose of this study was to ascertain whether following discharge from hospital after receiving a TKR, physiotherapy intervention or a patient-directed HEP was the best postoperative rehabilitation within the first six weeks following surgery.

The outcomes used to gain the necessary results to provide a holistic conclusion were: knee flexion, function, pain and QoL. The following information describes the results and findings from the study.

Results and findings of the main variables tested

Tests of normality were carried out on all data using the Shapiro-Wilk test. This test was chosen as there are less than 50 participants within the treatment and control groups. Based on these tests, a decision of whether to use parametric or non-parametric tests to analyse the data was made.

Variables	Control group	Treatment group
Flexion	0.024*	**0.940**
6MWT	**0.306**	0.026*
Pain	**0.092**	0.003*

Table 1 Results of test of normality using the Shapiro-Wilk tests

*Key: *Indicating statistical significance at p<0.05 implying non-normal distribution*
Bold face at p>0.05 implying normal distribution
6MWT = six-minute walk test

The tests showed that in each outcome measured, the control group and the treatment group had differing results, one showing normal distribution and the other non-normal distribution. The test result proved inconclusive as to whether parametric or non-parametric testing was to be used, so both the Independent T test (parametric) and the Mann-Whitney (non-parametric) were used. It was decided that for the purpose of this study the Mann-Whitney U test would be more appropriate.

Variables	Mean values for the control group *(standard deviation)*	Mean values for the treatment group *(standard deviation)*	p values
Flexion (degrees)	102.5 *(9.8)*	100.7 *(10.8)*	0.742
6MWT (metres)	332.4 *(78.5)*	369.1 *(88.0)*	0.402
Pain (visual analogue score)	1.4 *(1.0)*	1.1 *(1.2)*	0.227
QoL	14.8 *(6.1)*	12.4 *(4.1)*	0.065

Table 2 Mean and standard deviation of the main variables for the control and treatment groups using the Mann-Whitney U tests

Function

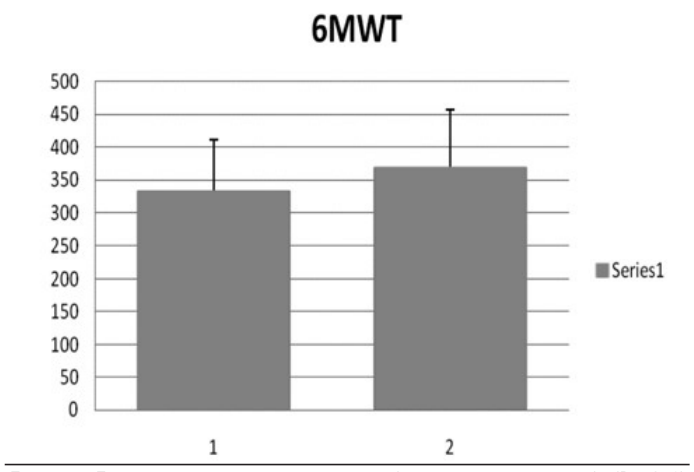

Figure 1 Functional ability at six weeks (six-minute walk test). (P>0.4)
Key: 1 = control group, 2 = treatment group

Range of Movement

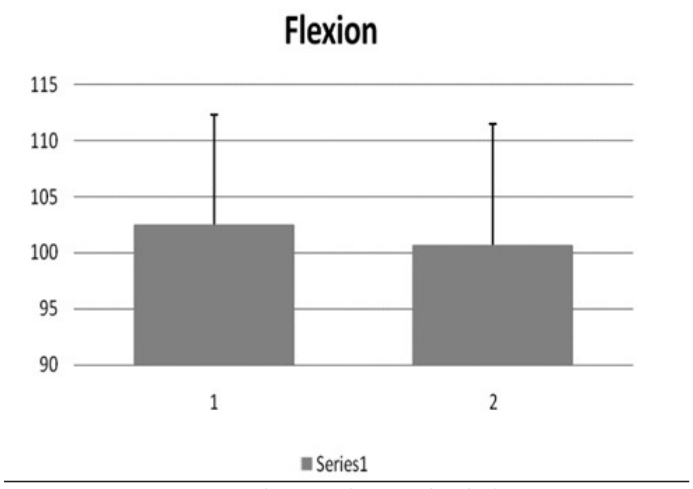

Figure 2 Knee flexion. (P>0.7)
Key: 1 = control group, 2 = treatment group

Pain

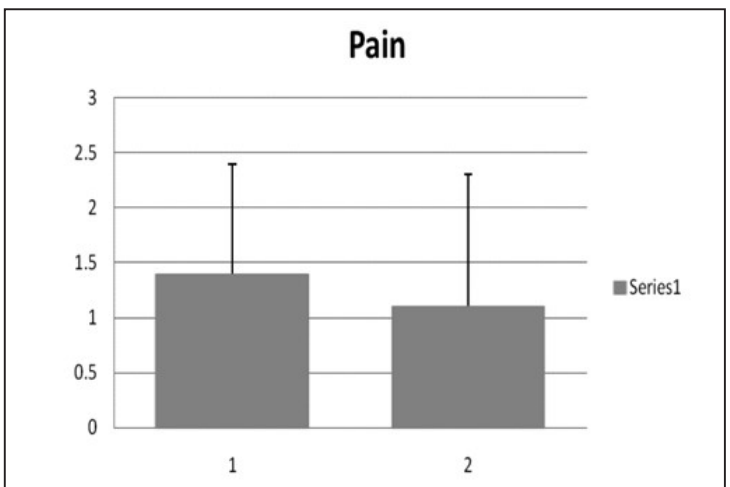

Figure 3 Pain levels (VAS) groups. (p>0.2)
Key: 1 = control group, 2 = treatment group

Quality of life

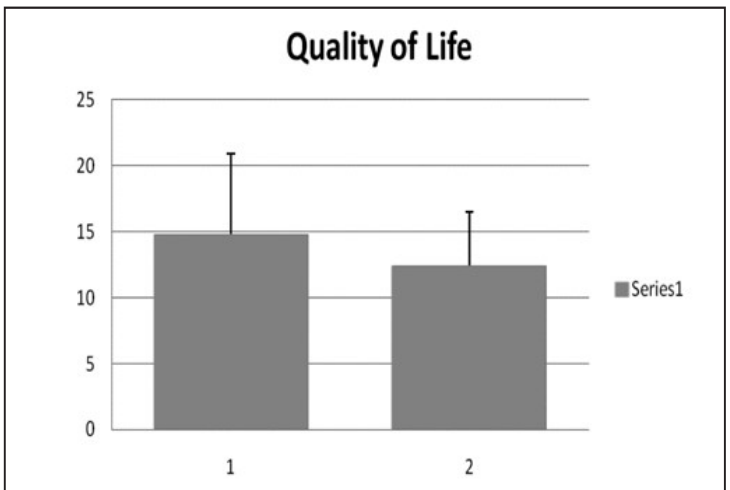

Figure 4 Quality of life using the SF12 questionnaire. (P=0.065)
Key: 1 = control group, 2 = treatment group

Table 2 displays the results of the four variables tested: knee flexion, functional ability, pain and QoL. Also, the mean values and standard deviation in the control and treatment groups, and the statistical significance (p value, p<0.05).

Reciprocal stair climbing

Results	Control group	Treatment group
% achieved at 6/52	59	70
% not achieved at 6/52	41	30

Table 3 Percentage numbers of participants able to achieve/unable to achieve reciprocal stair climbing six weeks postoperatively

Mean number of days before being able to climb stairs reciprocally six weeks postoperatively
Control group = 28 days. Treatment group = 27 days.
The percentage of participants who were able to reciprocally climb stairs was higher in the treatment group compared to the control group.

Walking unaided

Results	Control group	Treatment group
% achieved at 6/52	88	94
% not achieved at 6/52	12	6

Table 4 Percentage numbers of participants able to walk unaided/unable to walk unaided six weeks postoperatively

Mean number of days before being able to walk without a walking aid six weeks postoperatively
Control group = 19 days. Treatment group = 19 days.

DISCUSSION

This study was conducted to determine whether there was a significant difference between a patient-led HEP and physiotherapy outpatient intervention in combination with an HEP, from discharge from hospital to six weeks following surgery after a TKR. No other studies were found testing physiotherapy protocol in the first six weeks following surgery. To attain a robust study, four main outcomes were tested – range of movement, pain, function and QoL.

As a point of discussion, and to aid a possible explanation of results, other data were also collected at six weeks after TKR – ability to walk unaided, reciprocal stair climbing, compliance with ice application and HEP. These were not tested for significance, but for subjective information only.

The results of the study showed no significant differences between the control and treatment groups in any of the outcomes tested. These results are consistent with similar studies following a TKR.[6,7,8]

Range of movement

Results of our study are similar to those of another study whose authors conducted their study testing an HEP against inpatient physiotherapy.[6] Other studies also support these findings.[7,8] No studies were found with contrasting results.

Although not statistically, or even clinically, significant, it was noted that the control group achieved slightly more knee flexion than the treatment group (1.8 degrees). The reason for this is inconsistent with the other findings taken from the patient diary. In the diary, the participants were asked to indicate when they were able to reciprocally climb stairs and walk unaided by dating a box if the task was achieved. The treatment group achieved a higher percentage of participants able to reciprocally climb stairs and walk unaided. The treatment group also complied with the application of ice for a mean of 24 out of a possible 35 days of the study, compared with the control group who scored a mean of 19 days, which is converse to a 2006 study's expectation that the reduction of pain from cryotherapy could aid a greater range of motion.[12] Finally, compliance to the HEP was tested in both groups. The participants were asked to indicate daily if they had done their exercises over the 35 days of the study post-discharge from hospital; both groups proved to comply equally with a mean of 30 days.

An answer from the overall results regarding range of movement remains unclear, and there was no research found to help provide an explanation from other studies. However, an explanation could lie in the physiotherapy intervention at inpatient level. It is possible that the two groups achieved similar results due to the thorough identical physiotherapy protocol that the two groups received as inpatients on the ward. Both groups were instructed in the correct method to do their exercises, the number of repetitions, with emphasis placed on the importance of daily compliance. The importance of continuing their exercises and following advice regarding using ice as a pain relief was also reinforced regularly throughout their stay. This implies that if a comprehensive physiotherapy inpatient protocol is carried out with clear instructions, postoperative results for range of movement can be as effective with a self-directed programme as with physiotherapy intervention alongside an HEP.

Pain

Other papers testing inpatient physiotherapy against patient directed programmes showed similar results, despite using different methods to test pain as an outcome.[4,7] This study used the VAS, which can be considered to be a less subjective measure to test pain. No other studies were found using this method. No papers were found with contrasting results.

Observing supporting information gathered during the study, it can be noted that the treatment group complied with ice application with a mean of 24 out of 35 days compared to the control group who scored 19 out of 35 days. Although the results for pain were not significant, it could be suggested that the treatment group had less pain than the control group overall due to their more frequent ice application.[13] This could possibly be attributed to a reminder at treatment sessions by the physiotherapist to apply ice regularly.

Quality of life

A similar study supporting these results used the SF12 with no significant difference.[8]

These findings show that contact with a physiotherapist from discharge until six weeks following surgery does not significantly enhance a patient's general wellbeing, despite the subjective difference in scores between the two groups and the equal compliance with the HEP. The reasons for these findings are not clear, and no contrasting results were found in any other studies.

Although a reason for the results is not immediately obvious, there have been studies around self-efficacy to suggest that the higher the level of perceived self-efficacy for disability, the more effort patients may invest in exercise therapy.[14] It could

therefore be argued that if patient self-efficacy was supported by thorough inpatient physiotherapy intervention, ensuring that the patient was competent and confident with their HEP and had comprehensive advice, it could be a possible reason for the results of the two groups tested having similar results.

Function

Our findings correlate with a 2008 study, which failed to prove that outpatient physiotherapy improved the ability to walk further.[8]

Supporting data

The treatment group may have been able to walk further due to a higher percentage of participants being unaided at the time of testing, possibly due to intervention aiding gait re education.

CONCLUSIONS

It could be suggested that because all patients achieved 90 degrees range of movement before discharge, which is considered a functional range of movement,[4] both groups were able to progress accordingly and in a similar fashion.

This study was comprehensive compared to other studies in the subject area. It used several outcomes to test whether a self-directed HEP or physiotherapy intervention alongside an HEP was more effective. Range of movement, pain, function and QoL were used to make the results relevant, and a patient diary was provided to gain supporting information on compliance, reciprocal stair climbing and unaided gait to aid discussion. It looked at the above outcomes in the first six weeks following surgery for a TKR, which is a previously unexplored timeframe. However, although the study was robust, there are a several ways that it could be enhanced by future research.

The wider implications of the findings relate to *the patient*, in terms of convenience and improved self-efficacy, *the physiotherapy service*, by highlighting the importance of robust inpatient physiotherapy intervention, and the potential reduction of outpatient waiting lists by accelerating throughput, and *financially* by reducing the cost per capita for the overall care of a patient following a TKR. This suggests that a self-directed HEP could provide an effective and efficient protocol following a TKR within the current climate within the NHS.

RECOMMENDATIONS

Recommendations for future study

- Larger study size
- Double blinding
- Narrower age brackets for study
- Longer patient follow-up
- Establish pre-operative baselines
- Test for significance in the following outcome measures: reciprocal stair climbing and time to walking unaided
- Testing for muscle strength

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