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Effect Of Comprehensive Knee Rehabilitation Programme On Outcomes Of Pain And Function In Total Knee Replacement Patients With Osteoarthritis: A Longitudinal Follow-Up Study

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Abstract:

Background and Objective: Total Knee Replacement has been widely used as a treatment option if the conservative management fail in patients with knee osteoarthritis. Knee rehabilitation plays an important role in improvement of Pain and Function post surgery. The main objective of the present study was to assess the patients with Total Knee Replacement with reference to Pain and Function following the knee rehabilitation.
Methods: The subjects were recruited from a multispecialty hospital who got admitted for the Total Knee Replacement surgery (n=100). Patient's demographics, BMI (Body Mass Index, severity of osteoarthritis (K-L grading system), and the co-morbidities were evaluated prior to the surgery. The subjects were evaluated for pain and physical function using Knee Society Score, WOMAC and Oxford Knee Scores a day before the surgery, 3rd month following surgery, 6th month following surgery and 12th month following surgery.
Results: Improvement in mean pain score in KSS was found to be 58.1 points from pre operative evaluation to the 12th month whereas the function score in KSS was 52.9 points. Significant improvement in WOMAC and OKS scores was 64.5 points and 29.8 points respectively.
Conclusion: Significant improvement in the pain and function was found in patients with Total Knee Replacement by knee rehabilitation.

Keywords: KSS, WOMAC, OKS, Total Knee Replacement

1. Introduction

Total knee replacement is a major surgical procedure where improvement from surgery is enhanced with incorporating rehabilitation program so as to reinstate mobility and independence of individual. Recovery depends on various factors depending upon individual to individual. Moreover this betterment can be observed till 12 months following surgery[1]. In today's scenario Osteoarthritis is one of the most commonest cause of debilitating pain and dysfunction in seniors and which is linked to changes in lifestyle, hereditary disposition, environmental influences and lastly age related changes. Osteoarthritis is one of the most common existing condition which causes dysfunction in aged population. Osteoarthritis is one of the leading cause disability, where the articular cartilage is degenerated[2,3]. Patients who do not respond to the

conservative treatment total knee replacement is effective in procedure for pain reduction, improving life quality and correction of deformity. Osteoarthritis cause dysfunction, affects the aged psychologically and their activities of daily living[4-8]. Total knee replacement (TKR) is a economical procedure that improves pain, function and quality of life in patients with moderate to severe osteoarthritis[9]. The surgery is advisable to those patients when other treatment such as exercise, weight loss, analgesics, advices and precautions fails. 84% of patients were satisfied with their TKR, indicated 'good' for their satisfaction, a study done by National Joint Registry[10]. Post surgical Knee rehabilitation facilitates patient recovery in terms of pain and function. The first month following the knee replacement surgery has maximal amount of loss in strength and function[9]. There are various rehabilitation protocols which focus on improving pain, quadriceps strength and range of motion (ROM). However there is lack of rehabilitation protocols targeting pain and functional outcomes. Moreover there exist a few studies which have followed up patients post rehabilitation program to evaluate the long term effectiveness of rehabilitation. Therefore the present study aims to investigate the effect of knee rehabilitation protocol on outcomes of pain and physical function in patients with knee osteoarthritis. We hypothesised that the comprehensive knee rehabilitation programme will lead to significant improvement in pain and function outcomes in patients with knee osteoarthritis.

2. Methodology

2.1 Participants

The study was conducted at Superspeciality hospital , Indore . Study Procedure were carried out partially at hospital setting and then home based setting. The study was approved by the Ethics Committee of the hospital. All participants were asked to sign the consent form and were aware of the procedure and the potential risks in the study. Patients with Knee osteoarthritis (N=100) in moderate to severe category as per K-L grading system and with the age between 45-80 years were recruited in the study. All the patients with the history of Unilateral TKR, Hip ankle and spine arthritis, any history of CVA, cardiovascular accidents, patients who were not able to tolerate moderate level of exertion, cognitive or psychological disorders, progressive neurological diseases, malignancy, joint infection and osteoporosis were excluded from the study.

2.2 Experimental Procedures

Participants were subjected for Outcome measure assessment (KSS, WOMAC, Oxford Knee Score) pre operatively with in person demonstration of exercises. The exercise protocol was explained to each of the participants pre operatively and the whole procedure was explained to them so that they feel confident. The patients were requested to complete the scores (KSS, WOMAC, OKS) before the surgery and then at 3rd month, 6th month and 12th months follow up so as to measure the improvement in pain and functional outcome with the help of the scores used in the study as perceived by the patients following TKR and by objective scoring was evaluated with the Knee Society Score. Radiological assessment by Kellgren and Lawrence (K-L) system was done to assess the severity of the knee osteoarthritis. Gradings were done from 0 (No OA) to 4 (Severe OA). Gradings were done on the basis of presence of osteophytes and joint space reduction. There were no surgery related complications seen in the participants. Hospital stay for the patients was of 6-7 days and during the stay physiotherapy protocol on the first post operative day given was Static quadriceps, ankle toe movements (which was asked to perform every hourly for 10 reps by the patients) and standing with the help of walker support on the first post operative day. On the 2nd post day patient were taught how to sit and get up from the bed and chair, active knee bending exercises, active hip flexion was encouraged along with hip adduction and abduction exercises. These exercises were given along with the exercises which were performed on the day 1 post operatively. Gradually the patients were asked to increase the knee bends and isotonic quads was started when the bandages were removed but the dressing were on over the operative site till the stitch removal. Distance during ambulation was increased gradually as tolerated by the patient. Stair climbing was done on the 4th post operative day and the patients were discharged on 7th post operative day. After the discharge the patients received one month physiotherapy home programme which was done under the supervision of physical therapist and after one month of home exercise programme they were instructed to continue home exercises without the physical therapist. Home based exercise program included Ankle toe movements, static quads, Hip exercises, knee bends, ambulation with walker which was then progressed to stick and then without any assistive device, functional exercises were introduced. Strengthening exercises were started after 3 weeks post operatively. Home sessions were given for an hour for a day and the patients were asked to perform the exercises twice a day. The Scorings were done at hospital visit pre operatively, third month, sixth month and at one year.

Table 1 Rehabilitation protocol for the patients with Total Knee Replacement.

Post Operative Day	**Treatment given**
Day 1	Ankle toe exercises (Subjects were asked to repeat it every hourly), Static Quadriceps. (10 repetition twice a day) Ambulation with the help of walker support. Twice a day
Day 2	Exercises given on the first day along with Knee bends in sitting and supine positions (10 repetition twice a day) Transfer from bed to chair and chair to bed. Twice a day
Day 4	All the above exercises with Stair Climbing. Twice a day
Home Programme	All of the above exercises along with Functional exercises (10 repetition twice a day) Ambulation and stair climbing without assistive devices. Twice a day
Post 3 weeks	Strengthening exercises to be started with 1 kg weight cuff. (10 repetition twice a day)

3. Outcome Measures:

3.1 Knee Society Score

Insall in 1989, developed a Knee Society Clinical Rating System to evaluate knee prosthesis function and patients functional proficiency following total knee arthroplasty (TKA) [11]. The Knee Society Score, has two parts pain and function scoring, of which the pain score rates the severity of pain reported by the patient, flexion contracture, extension lag, range of motion, stability and alignment of the knee and a Knee Society Function Score, through which we can rate the patient's ability to walk, climbing stairs and the walking aids. The study includes the collection of data, information on pre and post operative pain and functional outcome which was assessed using KSS, WOMAC and OKS as main outcome measures before the surgery and at 3rd month, 6th month and 12th month post operatively. We have used the improvement in the scorings when the values showed improvement in post op period. The pain score and the functional scoring consists of 100 points each where the pain score is assessed clinically and the function score is based on patient reported outcome. The pain score has a pain component which is rated on basis of the intensity and the pain while climbing the stairs and the pain component has 50 points. The remaining 50 points in the pain score comprises of the flexion contracture, extension lag, range of motion, stability and alignment of the knee which is done by the clinical evaluation. The functional score comprise of 50 points which represent that the patient is able to walk unlimited and the stair climbing is normal and the patient does not use any walking aid. On the whole the function score is done on the basis of patient's ability to walk, climb stairs and use walking aids.[28,29] The study includes the collection of data, information on pre and post operative pain and functional outcome which was assessed using KSS, WOMAC and OKS as main outcome measures before the surgery and at 3rd month, 6th month and 12th month post operatively. We have used the improvement in the scorings when the values showed improvement in post op period[12,13].

3.2 WOMAC

In 1982 WOMAC was being developed by Western Ontario and McMaster Universities and has been validated and is available in various languages.[12,13] The WOMAC Index is used to evaluate 3 components viz pain (5 questions) which ranges between 0-20 points, joint stiffness (2 questions) which ranges between 0-8 points and Physical function (17 questions) which ranges between 0-68 points and it has been widely used in patients with Total joint replacement. High scoring indicates worse pain, stiffness and difficulty in functional activities. The is a variation in test-retest reliability of the three sub scores of WOMAC where pain subscale meets minimum standard, stiffness has low test-retest reliability and the physical function score has steady and strong test-retest reliability (American College of Rheumatology)[13.]

3.3 Oxford Knee Score

In 1998 Oxford Knee Score (OKS) was being developed which is easy to use and evaluates pain and level of functional limitations which the patient experiences in daily activities after the knee replacement [14.] The OKS is about how the pain has affected the patient's function over the preceding four weeks and it comprises of 12 questions[15]. The OKS comprise of total 48 points where 0 is the

lowest scoring indicating poor scores and 48 indicates maximal scores[15.] Moreover the OKS has test-retest reliability[14]. Various studies has shown good evidence for the validity and steadiness in OKS[14,16]. The OKS is predictive of patient satisfaction postoperatively.

4. Statistical Analysis

Subjects were evaluated using Knee Society Score (Pain & Function) , Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC Score) & Oxford Knee Score. Data entry was done using Microsoft excel and data were analysed using SPSS software version 20. All descriptive data were described as mean, standard deviation and frequencies where required. Normality of the data was tested using Kolmogorov Smirnov test. Non normal Variables were log transferred prior to further analysis. Paired t-test was employed in order to locate statistical differences in outcome variables within various time points. Statistical significance was set at in outcome variables. The significant differences in the mean scores were tested using paired t-test. Statistical analysis was done considering the p values which was found to be $p<0.05$ for the present study.

5. Results

All 100 participants enrolled in the study completed the study. The mean and standard deviation of the study participants was 68.6±4.20 years. with an average height (mean & SD) of 161.9±9.22. The mean and standard deviation weight of the subject was 71.5±6.91 with an average height (mean & SD) of 161.9±9.22. The mean & SD Body Mass Index (BMI) calculated was 27.5±3.03. Most of the patient were falling into overweight range.

Out of all participants Seventy were having Severe Osteoarthritis of Knee while 30 subjects had moderate osteoarthritic changes which was evaluated through the Kellegrens Lawrence Grading System.

Table 2. Demographic variables of knee osteoarthritis patients

Variables	Mean ± SD
Age (years)	68.6±4.20
Height (cm)	161.9±9.22
Weight (kg)	71.5±6.91
BMI (kg/m^2)	27.5±3.03
Severity (%)	
Moderate	30
Severe	70
Gender (M/F)	38/62
Co-morbidities (%)	
DM	17
HTN	94
Thyroid	7

SD: standard deviation; BMI: body mass index; M: males; F: females; DM: diabetes mellitus; HTN: hypertension

Pre and Post Operative comparison of Knee Society Score At baseline, 3rd Month, 6th Month & 12th Month

At the end of 12th month subjects were satisfied by the outcome when compared by the knee society score with reference to pain and functional outcome. There was statistically significant improvement from the baseline to 3rd month improvement and from the baseline to 12th month. With comparatively less improvement between 3rd to 6th month and 6th to 12th month.

Table 3. Descriptive statistics at baseline, 3 months, 6 months and 12 months post-operatively

Variables	Baseline Mean ± SD	3 month Mean ± SD	6 month Mean ± SD	12 month Mean ± SD	P values	
KSS Pain	14.1±15.03	60.6±13.72	69.5±7.83	72.2±5.86	<0.001*	<0.001*
KSS Function	36.2±18.41	77.3±15.48	89.9±11.50	94.1±9.65	<0.001*	<0.001*
WOMAC	30.8±15.61	82.1±15.43	92.9±8.03	95.3±8.35	<0.001*	<0.001*
OKS	13.5±5.91	35.4±6.83	41.1±5.37	43.3±4.79	<0.001*	<0.001*

KSS- Knee Society Score, WOMAC – Western Ontario and McMaster Universities Arthritis Index, OKS – Oxford Knee Score

Pre and Post Operative comparison of WOMAC Score At baseline, 3rd Month, 6th Month & 12th Month

WOMAC Scores Western Ontario and McMaster Universities Osteoarthritis Index total scoring is done on the following parameters such as stiffness, pain, and function scores. Statistically significant difference were found between different time intervals (Baseline, 3rd month, 6th month & 12th month) with significant improvement from baseline to 12th month but the difference was more significant between the baseline & 3rd month which was indicating a good patient satisfaction following total knee replacement.

Pre and Post Operative comparison of Oxford Knee Score At baseline, 3rd Month, 6th Month & 12th Month

The OKS signifies how the pain has affected the patient's function over the preceding four weeks and it comprises of 12 questions. Statistically significant improvement was seen in the oxford knee score with maximal improvement from pre operative state to 3rd month and drastic improvement from baseline to 12th month.

Table 4. Pairwise comparison of outcome variables at different time points

Pairwise comparisons	KSS knee score	KSS function score	OKS	WOMAC
Baseline versus 3 months	<0.001*	<0.001*	<0.001*	<0.001*
3 months versus 6 months	<0.001*	<0.001*	<0.001*	<0.001*
6 months versus 12 months	<0.001*	<0.001*	<0.001*	0.01*
12 months versus Baseline	<0.001*	<0.001*	<0.001*	<0.001*

KSS: Knee society score; OKS: Oxford knee score; WOMAC; Western Ontario and McMaster Universities Arthritis Index

6.0 Discussion

This study has shown that there was a statistically significant changes in Knee Society Scores, WOMAC Scores and Oxford Knee Scores in post operative patients at 3rd month, 6th month & 12th month as compared with the pre operative scores for the same. The improvements were more pronounced from pre operative status to 3rd month after the surgery in KSS, WOMAC & OKS as compared to the other time points.

Our study demonstrated that early rehabilitation along with weight bearing, strengthening, functional training and gait training has a great contribution which helps the patient to achieve pain free and functional independence in daily activities.

6.1 Knee Society Score after the rehabilitation

The results of this study demonstrated a significant improvement in functional aspects such as increased distance and independence in walking without aids, stair climbing. Moreover the symptoms of pain were also improved, with absence of extensor lag. Also significant improvement in the range of movement along with the improved stability of the knee joint was observed after the knee rehabilitation in the present study. The baseline mean was found as the pre operative mean score which was 14.1 points to the improved scores at 60.6 points at the 3rd month, 69.5 points at 6th month and 72.2 points at the end of 12th month. The improvement in the mean functional score was from 36.2 points pre operatively to 77.3 points at 3rd month, 89.9 at 6th month and 94.1 at the 12th month. There were difference of 46.5 points in the 3rd month and the difference of 8.9 points & 2,7 points in 6th and 12th month respectively in Knee Society Scores which indicates clinically significant improvement in pain & function post total knee replacement. In accordance with the findings of present study reported Arun H S et al 2016 did evaluation using KSS pre operatively and

post operatively at 3 months follow up and observed that the improvement in the mean pain KSS was 29 points minimum to maximum 83.4 points and mean functional score improvement was from 35 points to 83.5 points.[17]

Another study (Kim T. H. et al 2008), reported improvement in preoperative clinical scores as 30.9 points to 94.2 points following surgery and improvement in preoperative functional scores noted from 44.9 points to 84.7 points following surgery[18]. Moreover various studies (Kim Y. H. et al 2010), the pre operative mean clinical knee score was 35.3 points and the mean improvement of 94 points and mean functional score was 44.2 points preoperatively and a mean improvement of 83 points[19]. Venkatesan et al determined that patients satisfaction can be indicated by using the clinical and patient reported outcome measure following total knee replacement surgery. Evaluation of the patient pre and post operatively gives a better idea on the outcomes of surgery and to rehabilitate the patient accordingly. They found drastic improvement in patients symptoms and the final scores at 6th month following TKR[20]. Alexander et al reported on Knee Society Score's functional outcome of TKR, where 17 patients had osteoarthritis and 7 had Rheumatoid arthritis and a follow up for 10 year was done in young patients based on Knee Society Scores had 24 patients with a 10 year follow up was done and found no difference in 10 years in functional outcome based on the type of arthritis[21]. Another study (Johannes et al**)** concluded the treatment success at the end of 1 year 76.8% on the threshold for treatment success reported 76.8% of patient satisfaction at the end of 12 months whereas another study (Thambiah et al) reported 92.8% patient were satisfied post TKR.[22,23]

6.2 WOMAC

Walker LC et al in a study concluded that a blend of outcome measures and patient reported outcome measures indicates excellent outcomes post Total Knee Replacement and WOMAC is being most frequently used patient reported outcome measure[24]. Our study exemplifies by reflecting increasing awareness of improvement in the knee symptoms & stiffness though there was increase in strength of muscles specifically of quadriceps which was seen with the improvement in the functional activities as the strength was not assessed in the present study and positive changes in physical function in the patients who have undergone total knee replacement surgery. There was a difference of 51.3 points in the 3rd month, 10.8 points in 6th month post op and 2.4 points post operatively. The total improvement was of 64.5 points from the lower cut off values of 30.8 and higher cut off values of 95.3. These findings indicate that the knee rehabilitation results in positive changes in clinical symptoms but also in patient reports symptoms Study done by Escobar et al post 6th month following TKR surgery found improvement in initial WOMAC pain scores 55.6 to 31.62 final scores 365 knees post replacement and the initial functional scores from 58.24 to 27.22[25]. One year study done by Bachmeier et al reported enhancement in functional outcome, 53% correction with reference to pain and 43% correction with reference to stiffness in patients with osteoarthritis[26]**.** Walker et al classified total knee replacement patients as 67.5% who were very satisfied, 22.2% satisfied, 7.4 dissatisfied, 2.9% very dissatisfied at 1 year post operatively[24].

6.3 Oxford Knee Score

The present study suggests significant improvement in performance in functional activities with the physical therapy protocol as the pain reduced to a great extent and the mobility and strength contributed to the overall performance. There was significant improvement in function which is reflected by the independence functionally. Clement et al studied that the OKS is the most accurate predictor which shows the patients level of satisfaction having the threshold value of very satisfied patient with OKS scores of >36, with scores of >27 points for satisfied patients and <25 for unsatisfied patients[27]. The Oxford knee scoring in our study suggested a better outcomes post operatively one year after the Total Knee Replacement with the difference of 21.9 points in the 3rd month post operatively in comparison with the pre operative status and with the difference of 5.7 and 2.2 points at 6th & 12th month post operatively as compared with the 3rd and 6th month respectively. There were higher level of satisfaction among the subjects as the physical activities improved which affected them positively as compared to the pre operative status where the daily chores were affected. Graham et al concluded that Oxford Knee Score and Knee Society Score can predict patients satisfaction after 2 years with good precision. And this can give the idea to the surgeon to have an impression earlier by the threshold values for satisfactory patient outcome[28]. Williams et al studied about the long term trends on oxford knee score post total knee arthroplasty concluded that the mean OKS score post operatively was 19.5 and maximum score post operatively was observed at 2 years when the mean score was 34.4 and through the 10 year assessment the decline was found to be significant but gradual with mean score of 30.1[29].

In accordance with the study done for a year (Mohammed Anter Abdelhameed et al 2023) in patients following knee replacement surgery concluded that young age and if the patient has less stiffness has shown

greater improvement in Oxford Knee Score[30]. As discussed in a study (David et al., 2020) concluded that less Preoperative OKS resulted in substantial gain along with if the final scores are less there is substantial gain in in the life's quality[31].

Limitations of the study:

There was lack of control group in the study. Other objective measures such as strength were not measured in the present study. Further studies needs to be taken into account to validate the results of this research.

Conclusion

The treatment was considered more successful if the patient reported a higher level of satisfaction & pain relief, functional improvement and thus showing outcomes of TKR using clinical as well as patient reported outcome measures pre and post operatively for 1 year.

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