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Does preoperative therapy improve function in postoperative patients undergoing total knee arthroplasty?

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Abstract

Objective: The objective of this selective EBM review is to determine whether or not using "preoperative therapy can improve function in postoperative patients undergoing Total Knee Arthroplasty?"

Study Design: A review of three double-blinded randomized control trials (RCT) that were peered reviewed after 2014

Data Source: All articles were published in peer-reviewed journals and were researched using PubMed. Studies were selected based on their ability to answer the question posed in the objective, and if the researched outcomes were patient oriented.

Outcomes: Assessed outcomes were either from a Timed Up and Go test or Stair Climbing Test.

Results: Joaquin Calatayud et al. calculated a statistically significant p-value of <.0001 in comparing preoperative therapy with postoperative therapy compared to postoperative therapy alone. Pascale Gränicher et al. calculated a statistically insignificant p value<.984. Jose-Maria Blasco et al. showed a statistically significant p value<.0001.

Conclusions: Two RCTs showed significance based on the calculated p-value given. Preoperative training in combination with postoperative therapy results show evidence of improving function postoperatively. Future studies can work with a larger patient population alone with TENS units to speed neural networks recovery.

Keywords: TKA, preoperative therapy

Introduction

Total Knee Arthroplasty (TKA) is the elective surgery of choice for patients who fail conservative treatment options (i.e acetaminophen, NSAIDS, topical treatments, oral steroids, intra articular steroid injections) for pre-existing knee-related comorbidities (i.e osteoarthritis, degenerative joint disease, and/or trauma to the knee).[1,2] Annually, nearly 4 million patients receive supervised postoperative TKA physical therapy to aid in recovery, promote muscle strength, regain ROM, and improve knee functionality long term.[3] TKA improves overall functionality by restoring the knee's original anatomy but consequently results in sensorimotor deficits. [3] Furthermore, while a rehabilitation protocol is commonly practiced postoperatively, preoperative therapy can be used to reduce hospital stays by reducing overall medical costs for patients and postoperative pain.[2,3]

Medical costs are a large concern for many TKA patients, with costs reaching approximately $8,930 per patient, of which 60% were outpatient costs, 36% were inpatient costs, and 4% were emergency room costs.[4,5] Further cost analysis of TKA costs estimate that each patient should expect at least forty-nine healthcare follow-up visits with around thirty-three of those being dedicated to physical therapy.[5] Following a joint replacement, the debilitating reality of follow up and physical therapy place TKA patients at a significantly higher risk of falls and/or other joint damage.[3] As a result, preoperative therapy becomes even more beneficial to TKA patients by increasing muscle size and balance prior to surgery and reducing both the risk of preoperative joint damage and the odds favoring their contralateral side postoperatively.[6]

Preoperative physical therapy is currently being experimented to determine its usefulness in aiding patients to achieve faster recovery time and shortened length of stay. Not only does it build muscle but creates neural pathways. Once these pathways are established it is easier to

reactivate them after the trauma a patient's body must undergo after surgery.[1] The patient's has to recover after their injury because of the loss of the bodies function in the muscle's flexibility and balance. Muscles go through atrophy and stiffening due to limited use from pain which will ultimately affect the patient's balance. In order to reacquire the patient's functionality often patients will go through physical therapy which provides a set protocol for the patient to follow. Rehabilitation protocols have been proven to enhance patient satisfaction and overall functional capabilities postoperatively, however, while research suggests that preoperative therapy can aid in recovery of function post-surgery little is known regarding the applicability of preoperative rehabilitation protocols in postoperative patients undergoing TKA. In spite of the traditional approach to physical therapy postoperatively, preoperative therapy can be a nonpharmacologic treatment to help maintain/lessen the decrease of muscle atrophy, balance and neuromuscular involvement as patients wait for surgery.[7] The objective of this systematic review is to examine whether preoperative therapy improves function in postoperative patients undergoing Total Knee Arthroplasty.

Objective

This paper hypothesizes that preoperative therapy will improve the functional outcomes (ROM, Strength, of patients who undergo combined pre and postoperative therapy as opposed to postoperative therapy alone.

Methods

Three Randomized Control Trials (RCTs) were selected with a specific patient population undergoing TKA. The intervention assessed was patients receiving preoperative therapy combined with postoperative therapy compared to patients only receiving postoperative therapy. Patient functionality was assessed through the Timed Up and Go (TUG) test[2,7] and Stair

Climbing Test (SCT).[1] There are three randomized, double blind, placebo-controlled clinical trials comparing preoperative therapy with postoperative therapy to only postoperative therapy after patients undergo a TKA. The database used for this systematic review was PubMED. The keywords were as follows: *TKA and preoperative therapy*. Studies that included TKA patients in their samples, were RCTs, available in full text, published in peer-reviewed journals after 2014 and were written in English were included in this review. Reasons for exclusion were duplicate articles, systematic reviews, those that did not examine the association between preoperative and postoperative therapies impact on functionality in TKA patients, and those published before 2013 to maintain rigor and current evidence. The articles were obtained based on relevance to answer the clinical question and discuss an innovative treatment intervention that includes patient-oriented outcomes. All articles conducted statistical analyses using p values and mean changes from baseline to assess the summarized data.

Table 1. Demographics and Characteristics of Included Studies

Study	Type	# Patients	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Calatayud 2017 (1)	Double blind RCT	50	Patients ≥60 years of age	Patients ≥60 y/o, diagnosis with advanced osteoarthritis scheduled for unilateral TKA	Patients <60 y/o, pain in the contralateral limb, has previously had hip or knee replacement in the last year, if exercise was contraindicated by a medical condition.	6	The main program was 5 sets of 10 reps for each exercise with 60-s rest 3 days a week for 8weeks. Emphasis on strengthening lower extremities for each exercise.

Gränicher 2020 (2)	Double blind RCT	20	>18 years old	Patients >18 receiving unilateral TKA at the Department of Orthopaedics of Blagrist University	If patients suffered from muscle weakness due to neurologic disease, BMI>33kg/m^2, depression, patellar instability, inflammation of joints, or planned tibial tuberosity.	0	3 to 4 weeks prior to surgery the IG completed 5 to 9 sessions of PT containing proprioceptive neuromuscular facilitation (PNF) techniques, endurance training and individually indicated interventions.
Blasco 2020 (3)	non-blind RCT	86	60-80 years old	Patients 60-80 years old waiting for a total knee placement, needed to understand PT instructions, 20 in Mini Mental	Central or vestibular limitations affecting balance or presenting with postoperative complications such as DVT.	9	The hospital group implemented a four-week preoperative outpatient balance-oriented intervention.

Outcomes Measured

The functional outcomes were measured by two tests: the TUG test and SCT one month and six weeks after surgery. The Timed Up and Go test (TUG) is a brief assessment of balance, mobility, lower extremity function and fall risk without the use of any special equipment.[2,7] SCT assesses the patient's ability to ascend and descend a flight of steps in a timely manner with limited use of the handrail, a safety precaution, not to assist the patient.[1,2] Both assessments are useful to aid the patients and providers in understanding how a patient's activities of daily living (ADLs) and level of functionality post-TKA will be impacted.[1,2,7]

Results

Calatayud et al. [2] conducted a double-blinded RCT that compared the effects of using preoperative therapy in combination with postoperative therapy in patients undergoing TKA. The population consisted of 50 participants who were >60 years old, diagnosed with advanced stage osteoarthritis (OA), and undergoing a unilateral TKA at "a local hospital in 2014.[2]" Individuals were chosen based on inclusion and exclusion criteria listed in Table 1. Participants were randomly selected via a computer, using a double-blind method, into the control and experimental group based on a number assigned during recruitment. After completing informed consent, each participant received the same postoperative therapy; an exercise program designed to restore knee range of motion (ROM), strength, and gait.[2] Patients in the experimental group performed a lower extremity exercise regimen three days a week for 8 weeks to target muscular strength building.[2] Out of the 50 participants, 6 dropped out due to postoperative complications, attrition, refused surgical intervention, and relocating to a different city. Loss to follow up was less than 20% throughout all studies.

Three data time points were collected at baseline, right before surgery and 1 month after surgery. Statistical data is reported below (see Table 2). The statistical analyses presented by Calatayud et al. [2], to measure postop function were presented as mean values, standard deviation, and p-values. Statistically significant differences were found between the control group (CG) and interventional group (IG) at each time point for the TUG test using a P-value of < .0001. Participants at baseline had no significant difference between both groups with a between-group difference of -0.1 (-0.6-0.3). Once preoperative training was initiated, the mean score of the TUG test for the IG was 6.7 (6.4-6.7) and the CG without preoperative training was 9.0 (8.7 to 9.4) showing a between-group difference of 2.3 (1.8 to 2.7). In contrast, one month after surgery both

groups who underwent the same postoperative therapy showed a between-group difference of 2.1 (1.7 to 2.6) with the CG being 9.4 (9.0 to 9.7) and IG 7.3 (6.9 to 7.6).

Table 2. Timed Up and Go Mean Score ± STD Change from Baseline with a CI= 95%

	Baseline	Before Surgery	1 month After Surgery	P-value
Post-op therapy only	8.5 (8.1-8.8)	9.0 (8.7 to 9.4)	9.4 (9.0 to 9.7)	<.0001
Pre-op and post op therapy	8.6 (8.3-9)	6.7 (6.4 to 7.1)	7.3 (6.9 to 7.6)	<.0001
Between Group Difference	−0.1 (−0.6 to 0.3)	2.3 (1.8 to 2.7)	2.1 (1.7 to 2.6)	

Gränicher et al. [1] conducted a double-blind RCT comparing the effects of preoperative therapy in combination with postoperative therapy in patients undergoing TKA. This study included 20 adults over the age of 18 (mean age 67 ± 7 years) and undergoing a unilateral TKA at Balgrist University Hospital. Inclusion and exclusion criteria are listed in Table 1. Participants were randomly assigned to a CG and IG via computer generated randomized list. Participants were separated after baseline testing was finished. The IG underwent 5 to 9 physical therapy sessions 3-4 weeks before surgery.[1] The IG's focused on neuromuscular control and the strength of lower extremities. Both CG and IGs postoperative therapies consisted of the same therapy and duration. Two participants were unable to complete the entire IG therapy due to absence from work or vacation, but data were included because they completed approximately 96.7% of the IG exercise.[1] The statistical analyses presented by Gränicher et al. [1], to measure postop function

were presented as mean values, standard deviation, and p-values. No adverse effects or events were reported throughout the study.

No difference between IG and CG was found for SCT with a p-value <0.984. Table 3 depicts no significant difference between the CG and the IG at any time point throughout the study. For the IG, the Stair Climb Test (SCT) recorded 12.68 ± 5.00 before the surgery and 12.58 ± 4.64 after the surgery. For the CG before the surgery SCT was 14.11 ± 9.19 and after 1 month 13.59 ± 5.30.

Table 3: Baseline, Before Surgery, and 1 Month After Surgery Stair Climbing Test Results (Seconds)

	Baseline	Before Surgery	1 month After Surgery	P-value
Postop therapy only	13.54 ± 7.35	14.11 ± 9.19	13.59 ± 5.30	<.984
Pre-op and post op therapy	12.37 ± 3.74	12.68 ± 5.00	12.58 ± 4.64	<.984
Between Group Difference Calculated	1.17	1.43	1.01	

Blasco et al.[7] conducted a non-blinded RCT that compared the effects of using preoperative therapy in combination with postoperative therapy in patients undergoing TKA. A total of 86 participants between the ages of 60-80 years old underwent a unilateral TKA at University Hospital. Inclusion and exclusion criteria are listed in Table 1. Participants were randomized using a number generator from an external source and split into 3 groups: *at home*

preoperative therapy, hospital based preoperative therapy, and CG. The IG would perform 12 training sessions that were spread out over the 4 weeks before the participants surgery.[7] The IG training program focused on lower limb strengthening along with balance training. Both CG and IGs would perform the same postoperative TKA therapy protocol focusing on strengthening, balance, proprioception. A total of 9 participants left the study due to cancelled surgery, refused hospital-based therapy, surgical complications, and personal reasons.[7]

The outcome measured in the study by Blasco et al.[7], was knee function in terms of the TUG test along with a multitude of other examinations that will not be discussed in this analysis. The statistical analyses presented by Blasco et al.[7], to measure postop function were presented as mean values, standard deviation, and p-values. Participants were scored before their surgery, two weeks after and six weeks after their surgery. The data, however, will be reported with two timepoints: before TKA surgery and six weeks after surgery. The CG was tested prior to surgery, receiving a mean score of 18.9 with a standard deviation of 11.2 and then tested 6 weeks after surgery with a mean score of 16.5 with a standard deviation of 6. The IG was compared to these findings showing a mean score of 18.8 with a standard deviation of 7 for at home therapy and a mean score of 17.7 with a standard deviation of 6 for hospital-based therapy before surgery. After surgery, at-home therapy had a mean score of 16.8 with a standard deviation of 5.4 and hospital-based therapy had a mean score of 16.2 with a standard deviation of 5.

Table 4: Before Surgery and 6 Week Postoperative Timed Up and Go Average (Seconds) CI=95%

	Before Surgery	6 weeks After Surgery	P-value

Postop therapy only	18.9 ± 11.2	16.5 ± 6.0	<.0001
Pre-op and post op therapy home based	18.8 ± 7.0	16.8 ± 5.4	<.0001
Pre-op and post op therapy hospital based	17.7 ± 6.0	16.2 ± 5.0	<.0001
Between Group Difference (control vs home therapy) Calculated	.01	-0.3	
Between Group Difference (control vs hospital therapy) Calculated	1.2	0.3	

Discussion

TKAs are an invasive medical intervention with a burdensome recovery process and lengthy rehabilitation. While TKA's are commonly recommended for a myriad of patients (i.e severe osteoarthritis, degenerative joint disease, and trauma) with various knee conditions they are often associated with acutely elevated pain, post-surgical complications, and out of pocket costs. If a patient can receive treatment to reduce overall postoperative TKA burden, they can return to activities of daily living more rapidly than ever before. Preoperative therapy, conducted in conjunction with postoperative therapy can enhance early postoperative recovery by improving ROM, muscle strength, balance and overall muscle tone faster than conventional postoperative therapy.[1,2,7]

This selective EBM review evaluated the efficacy of preoperative therapy in conjunction with postoperative therapy to improve overall knee function after TKA. Calatayud et al.[2] and

Blasco et al.[7] showed a significant p-value of <.0001 in relation to the effectiveness of preoperative therapy in improving overall knee function after TKA whereas Gränicher et al. [1] revealed statistically insignificant data related the effectiveness of preoperative therapy on postoperative knee function with a p value of < .984. Gränicher et al.[1] did show, however, a 1.01 second difference between the IG and the CG after surgery that was positively associated with preoperative therapy. Calatayud et al.[2] demonstrated the largest mean difference between IG and CG was a mean of 2.1. In the study conducted by Blasco et al.[7], the mean difference between IG and CG was 0.3. Gränicher et al.[1] also had a mean difference between IG and CG of 1.01. Overall, two of the three RCTs revealed statistically significant results based on their p-values.[1,7] As such, more research must be conducted with larger sample sizes to improve reliability and validity in studies examining post-operative TKA's and the effectiveness of preoperative therapy in improving overall functionality of patients' knees postoperatively.

The studies included in this review consisted of some limitations. Only two of the three also followed a double-blind procedure which could increase the chance for performance bias.[1,2] Exclusion criteria included a variety of neuromuscular injuries/disorders affecting various joints other than a unilateral knee that is pertinent to TKA which may be representative of the general population. Contraindications to consider are uncontrolled cardiovascular disease. None of the studies explicitly considered high risk cardiovascular patients who may not be a reliable participant due to increased fall risk and reduced ability to tolerate physical therapy. Patients with uncontrolled cardiovascular disease are also at increased risk of developing stroke, myocardial infarction and possibly death making it important to consider these at-risk populations that may be more representative of the general public. Furthermore, ineffective pain control may be present but was not considered as a limitation in any of the studies. In the RCT

conducted by Blasco et al.[7], which included home based therapies, limitations were not listed related to the potentially detrimental impact of contraindications for high risk patients such as these. Furthermore, each of the RCTs included sample size as a limitation to their studies.[1,2,7]

Conclusion

All three RCTs that were included in this selective EBM review demonstrated that combination preoperative and postoperative therapy improves the function of TKA patients' affected knee following surgery compared with those performing postoperative therapy alone. The treatment effect in each study was determined to be large based upon the mean score difference between CGs and IGs. All RCTs claim preoperative therapy does improve function in a TKA postoperatively. However, the hypothesis is inconclusive due to conflicting data and larger studies need to be performed in order to make the data more significant.

Future studies considering the impact of combined preoperative and postoperative therapy should use a larger sample size and consider the importance of pain control's limitations on a study. In addition, future studies should further divide preoperative therapy groups into subsets such as high intensity training, low intensity training, balance training, and/or neurosensory training to broaden eligible participants and reduce the inherent bias of convenience sampling. It may be beneficial to continue to employ double-blind study procedures and take into consideration the various environmental, visceral, cultural, and emotional conditions of study participants that could cause reporting bias. Future studies can include the use transcutaneous electrical nerve stimulation because it has shown beneficial data in patient's pain, function, and inflammation.[8]

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