

The Role of Physical Therapy in Decreasing Length of Stay Following Total Knee Arthroplasty in a Public Hospital Setting

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ABSTRACT

BACKGROUND: The goal of this study is to analyze how a modified PT protocol affects length of stay following TKA in the public hospital patient population.

METHODS: A retrospective review of 157 patients that underwent unilateral primary TKA was done. Basic demographics, perioperative and post-discharge characteristics were collected on TKA patients one year prior and one year following the initiation of a new PT

protocol.

RESULTS: There were 94 patients in the non-intensive PT cohort and 63 in the intensive PT cohort. Hospital LOS was significantly shorter in the intensive PT cohort (2.0 versus 3.9 days; $p < 0.001$). There was no difference in complication rates, ED-visits within 90 days, or 90-day readmission rates between the non-intensive and intensive cohorts, respectively.

CONCLUSION: In this study, we found that an intensive PT regimen significantly decreased LOS and increased home discharge for patients after TKA without negatively affecting postoperative clinical outcomes.

Key words: Total knee arthroplasty; Physical therapy; Postoperative care; Postoperative outcomes; Rehabilitation

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INTRODUCTION

As the global population continues to age, there will be an increase in the number of total knee arthroplasties (TKA) performed annually. In the United States, the incidence of hip and knee replacements is estimated at greater than one million per year, with projections reaching 3.48 million procedures annually by 2030^[1,2]. The increases in the volume of procedures is likely secondary to increased diagnosis of degenerative joint disease in conjunction with a growing patient population and improved life expectancy of those patients requiring operative intervention^[2,3]. Alongside the increase in volume of these procedures, discussion surrounding overall healthcare and hospital costs will come to the forefront of operative planning.

One main factor that influences the cost of total knee arthroplasty (TKA) is patient length of stay (LOS) following surgery^[4]. According to the Kaiser Family Foundation data, average daily hospital inpatient

cost across the United States has doubled from \$ 1000 per day in 1999 to over \$ 2000 per day in 2015^[5]. This dramatic increase in cost has likely been partially offset by the trend to decrease patient LOS after TKA surgery. Currently, the LOS following TKA averages 3.7 days in the Medicare population^[6,7]. Certain perioperative factors have contributed to the overall decrease in patient LOS including systems-based practices to decrease complication rates, changes in implant design, minimally invasive techniques, multi-modal pain management, and physical rehabilitation protocols^[8].

Physical therapy (PT) is one of the mainstays of postoperative management following TKA. PT has been shown to reduce swelling, increase range of motion, improve strength, and return individuals to a higher level of function following TKA^[9-13]. There is limited data in the current literature, however, regarding the exact means and types of protocols that decrease LOS for patients following TKA. Some studies have found that implementation of PT protocols have decreased the hospital LOS by 1.3 days for patients undergoing TKA^[14]. A recent systematic review has similarly found that for those patients undergoing total knee, hip or unicompartamental knee arthroplasty initiation of early PT significantly decreased LOS and overall hospital cost following these procedures^[13]. One study that analyzed the role of postoperative day (POD) 0 PT solely found significant decrease in LOS for total hip arthroplasty (THA) patients, but not for TKA patients^[15]. Thus, there remains uncertainty in the literature regarding the exact modality by which PT functions in the

overall hospital course, LOS, and ultimately cost of an in-patient TKA episode of care.

The goal of this study is to analyze how changing the PT protocol from POD 1 to POD 0 and increasing PT frequency from 1 to 2 sessions a day may affect the LOS and secondary patient outcome measures and complications following TKA in a public hospital patient population. Our hypothesis is that the implementation of a more intense PT protocol, that includes PT initiation on POD 0 and an increased frequency of PT sessions, will significantly decrease the LOS for this patient population following TKA.

MATERIALS AND METHODS

Design

A retrospective review at a public hospital was conducted. Data was collected on patients undergoing arthroplasty one year prior and one year following the initiation of a new PT protocol for arthroplasty patients.

Patients

Following institutional review board (IRB) approval, we conducted a retrospective review on all patients that underwent TKA at a public hospital in a large metropolitan city that serves a diverse patient population. Inclusion criteria included patients greater than 18-years old, primary TKA, and elective indication at the time of surgery.

Table 1 Comparison of non-intensive and intensive PT protocols.

Time Interval	Non-intensive	Intensive
Frequency	Often seen 1x/day	POD 0: 1x/day; POD 1-2: 2x/day or as needed*
Day of Surgery (POD 0)	Supervised out of bed to chair transfers	Supervised out of bed to chair transfers
	Gastrocnemius stretching/ Ankle pumps	Gastrocnemius stretching/ Ankle pumps
	Quadriceps/Hamstring isometric stretching	Quadriceps/Hamstring isometric stretching
	CPM machine: 0-30° (2 hrs/day) with full active flexion & extension	Active assisted knee flexion/extension as tolerated
POD 1	Supervised out of bed to chair transfers	Supervised out of bed to chair transfers
	Gastrocnemius stretching/ Ankle pumps	Gastrocnemius stretching/ Ankle pumps
	Quadriceps/Hamstring isometric stretching	Quadriceps/Hamstring isometric stretching
	CPM machine: 0-30° (2 hrs/day, 3 times per day) with full active flexion & extension	Active assisted knee flexion/extension to 60°
	Supervised ambulation for 50 feet with walker/crutches WBAT	Supervised ambulation for 50 feet with walker/crutches WBAT
	Illustrated exercise program given to patient	Supervised stair negotiation 4-6 steps, step to step pattern, WBAT
POD 2	Independent out of bed to chair transfers	Independent out of bed to chair transfers
	Gastrocnemius stretching/ Ankle pumps	Gastrocnemius stretching/ Ankle pumps
	Quadriceps/Hamstring isometric stretching	Quadriceps/Hamstring isometric stretching
	CPM machine: 45-60° (2 hrs/day, 3 times per day) with full active flexion & extension	Active assisted knee flexion/extension to 90°
	Supervised ambulation for 100 feet with appropriate assistive device using walker/crutches WBAT	Modified independent ambulation for 100 feet with appropriate assistive device using walker/crutches WBAT
	Supervised stair negotiation	Independent illustrated exercise program
	Independent illustrated exercise program	Patient discharged
POD 3	Independent out of bed to chair transfers	
	Gastrocnemius stretching/ Ankle pumps	
	Quadriceps/Hamstring isometric stretching	
	CPM machine: 60-90° (2 hrs/day, 3 times per day) with full active flexion & extension	
	Independent ambulation >150 feet with walker/crutches WBAT	
	Independent stair negotiation	
	Review and modify illustrated exercise program	

*Treatment could be 1-2x/day based on the patient's ability to: (1) Perform all transfers and bed mobility independently or modified independently; (2) Ambulate modified independently a minimum of 50 feet with a walker or cane (50 feet for a household ambulatory or 150 feet for a community ambulator). POD: post-operative day; CPM: continuous passive motion; WBAT: weight-bearing as tolerated; hrs: hours.

Exclusion criteria included any patient younger than 18-years old at the time of surgery, patients undergoing revision arthroplasty, patients presenting to the emergency department with indication for arthroplasty following acute trauma to the joint and non-elective arthroplasty. We collected data on patients undergoing arthroplasty one year prior and one year following the initiation of a new PT protocol for arthroplasty patients.

Procedures

Prior to June 2016, our post-operative PT protocol for TKA patients began on POD 0, however it was not required or strictly encouraged. POD 1 rehabilitation consisted of supervised transfers, stretching, knee flexion/extension, and ambulation with a PT therapist. POD 2 expanded on POD 1 activities, as well as included the addition of a stair climb. POD 3 rehabilitation consisted of more demanding POD 2 PT activities. The PT therapist supervised and worked with the patient once a day from POD 0 to POD 3. After June 2016, a more rigorous PT protocol was implemented with the goal of mobilizing postoperative TKA recipients earlier and expediting their hospital course. In brief, if the patient was able, it was now strongly encouraged for all patients to begin working with a therapist on POD 0. Additionally, beginning on POD 1, patients were now seen by a therapist twice a day instead of once, were encouraged to ambulate independently instead of supervised

on POD 2, and were encouraged to attempt a stair climb on POD 1 instead of 2. A more detailed description of the PT protocols can be found in Table 1.

For the purposes of the study, we defined the PT protocol prior to June 1, 2016 to be non-intensive and the PT protocol after June 1, 2016 to be intensive. For both protocols, a patient was deemed safe to be discharged if they met the following goals: (1) Patient is able to perform all transfers and bed mobility independently or modified independently; (2) Patient is able to ambulate independently a minimum of 50 feet with a walker or cane (50 feet for a household ambulator or 150 feet for a community ambulator); (3) Patient has the ability to freely flex their knee 70-90°

Patient baseline characteristics including age, gender, race, body mass index (BMI), American Society of Anesthesiologists (ASA) score, smoking status, discharge disposition, payer type, and date of surgery were collected. Perioperative details including hospital LOS, discharge disposition, and whether the patient received PT on POD 0 were collected. Post-discharge characteristics including complications related to the surgery, all 90-day emergency department (ED) visits, and all 90-day readmissions were collected.

Statistical Analyses

Data was collected, de-identified, and stored on Excel software. All descriptive and inferential statistics were conducted using SPSS v23 (International Business Machines, Armonk NY) statistics software. Chi-square and Fisher's exact test were used to compare categorical baseline patient demographics. Comparative analysis using a paired two-tailed student's *t*-test was used to compare means with variances among continuous variables between the two cohorts. A *p*-value < 0.05 was deemed statistically significant.

RESULTS

Patient Demographics

From January 2014 to June 2017, we identified 157 patients who underwent primary TKA at our institution and met our inclusion criteria. There were 94 patients in the non-intensive PT cohort and

Table 2 Primary TKA Patient Demographics.

Patient Characteristics	Non-intensive PT (n = 94)	Intensive PT (n = 63)	<i>p</i> -value
Age y ± SD (range)	64.5 ± 9.6 (20-82)	65.0 ± 10.3 (37-85)	<i>p</i> = 0.08
Sex			<i>p</i> = 0.38
Male n (%)	19 (20.0%)	16 (25.4%)	
Female n (%)	75 (80.0%)	45 (74.6%)	
Race			<i>p</i> = 0.19
White n (%)	10 (11.0%)	2 (3.8%)	
Black n (%)	23 (25.3%)	12 (23.1%)	
Hispanic n (%)	43 (47.3%)	33 (63.5%)	
Asian n (%)	15 (16.5%)	5 (9.6%)	
BMI kg/m ² ± SD (range)	31.9 ± 4.9 (20.7-42.8)	31.3 ± 5.7 (21.6-43.2)	<i>p</i> = 0.46
ASA score			<i>p</i> = 0.22
I n (%)	8 (8.5%)	3 (5.0%)	
II n (%)	76 (80.9%)	45 (75.0%)	
III n (%)	10 (10.6%)	12 (20.0%)	
Smoking status			<i>p</i> = 0.28
Never smoker n (%)	65 (69.2%)	45 (73.8%)	
Former smoker n (%)	5 (5.3%)	6 (9.8%)	
Current smoker n (%)	24 (25.5%)	10 (16.4%)	
Discharge disposition			<i>p</i> = 0.03
Home n (%)	71 (75.5%)	55 (90.2%)	
SAR n (%)	7 (7.4%)	2 (3.3%)	
SNF n (%)	16 (17.0%)	2 (3.3%)	
Shelter n (%)	0	1 (1.6%)	
Eloped n (%)	0	1 (1.6%)	
Insurance			<i>p</i> = 0.31
Medicaid n (%)	54 (57.4%)	42 (66.7%)	
Medicare n (%)	4 (4.2%)	1 (1.6%)	
Private n (%)	0	1 (1.6%)	
Unknown n (%)	36 (38.4%)	19 (30.1%)	

PT: physical therapy; BMI: body mass index; ASA: American Society of Anesthesiologists; SAR: subacute rehab; SNF: skilled nursing facility.

Table 3 Primary TKA perioperative characteristics

Perioperative characteristics	Non-intensive PT	Intensive PT	<i>p</i> -value
Hospital LOS days ± SD (range)	3.9 ± 2.56 (1-13)	2.0 ± 1.11 (1-7)	<i>p</i> < 0.0001
PT POD 0			<i>p</i> < 0.0001
Yes n (%)	18 (19%)	40 (65.6%)	
No n (%)	76 (81%)	21 (34.4%)	

PT: physical therapy; LOS: length of stay; POD: postoperative day.

Table 4 Primary TKA post-discharge characteristics.

Post-discharge characteristics	Non-intensive PT	Intensive PT	<i>p</i> -value
Complication			<i>p</i> = 0.78
Yes	10 (10%)	5 (16.7%)	
No	83 (90%)	55 (83.3%)	
90-day ED visit			<i>p</i> = 0.57
Yes	24 (26.4%)	13 (21.7%)	
No	67 (73.6%)	47 (78.3%)	
90-day readmission			<i>p</i> = 0.99
Yes	9 (9.6%)	6 (9.5%)	
No	85 (90.4%)	57 (90.5%)	

PT: physical therapy; ED: emergency department.

63 in the intensive PT cohort. The mean age in the non-intensive cohort was 64.5 ± 9.6 and the mean age in the intensive cohort was 65.0 ± 10.3 . The non-intensive cohort included 19 (20%) males and 75 (80%) females, while the comparator cohort included 16 (25.4%) males and 45 (74.6%) females. The mean BMI was 31.9 ± 4.9 kg/m² in the non-intensive cohort and was 31.3 ± 5.7 kg/m² in the comparator cohort. Seventy-one (75.5%) patients in the non-intensive PT cohort were discharged home, compared to 55 (90.2%) patients in the intensive cohort ($p = 0.03$). Insurance payer type amongst both cohorts was similar ($p = 0.31$), with most patients insured under Medicaid. Patients who had both Medicaid and Medicare were included in the Medicaid subgroup. Evaluation of age, gender, race, BMI, ASA score, smoking status, and insurance type revealed no statistically significant differences between the non-intensive and intensive PT cohorts ($p > 0.05$). Detailed information on race, ASA score, smoking status, and insurance type can be found in Table 2.

Analysis of Perioperative Characteristics

Perioperative characteristics were evaluated to assess the effect more intensive PT has had on a primary TKA patient's perioperative course (Table 3). The majority of patients (81%) did not receive PT on POD 0 in the non-intensive cohort while the majority of patients (65.6%) did receive PT on POD 0 in the intensive cohort ($p < 0.001$). This demonstrates the effective implementation of the modified PT protocol. Hospital LOS was significantly shorter in the intensive PT cohort (2.0 versus 3.9 days; $p < 0.001$).

Analysis of Post-discharge Characteristics

Post-discharge characteristics, including complications, 90-day ED visits, and 90-day readmission rates, were collected and analyzed to assess the safety of the modified PT protocol (Table 4). Ten patients (10%) and 5 patients (16.7%) had complications related to their primary TKA in the non-intensive and intensive cohorts, respectively ($p = 0.78$). There was no difference between ED visits for any reason within 90 days after surgery between the non-intensive (26.4%) and intensive (21.7%) cohorts ($p = 0.57$). There was no difference in 90-day readmission rates between the non-intensive (9.6%) and intensive (9.5%) cohorts ($p = 0.99$) (Figure 1).

DISCUSSION

As the demand for TKA continues to increase, a greater focus has been placed on delivering high quality orthopaedic care. Our study sought to identify the role of intensive PT in decreasing LOS for patients following TKA in a public hospital setting. Currently, there is a paucity of literature assessing the role of PT protocols in TKA, specifically as it relates to LOS and other postoperative quality metrics.

In our current study, the implementation of same-day PT (POD-0), and twice a day sessions significantly decreased the LOS for patients following TKA ($p < 0.01$) from a mean of 3.9 days to 2.0 days, without any increase in adverse outcomes. In previous studies, decreased LOS for patients undergoing TKA has similarly been reported. For example, Isaac and colleagues utilized an accelerated rehabilitation protocol to decrease LOS for patients undergoing TKA, which included infiltration of bupivacaine and adrenaline to the divided tissue layers at the time of surgery, spinal anesthesia, and mobilization on the day of surgery^[16]. This interdisciplinary rehabilitation protocol was successful in reducing overall LOS for patients after TKA. Labarca *et al* also found that initiation of PT within 24-hours of surgery was correlated with decreased LOS for

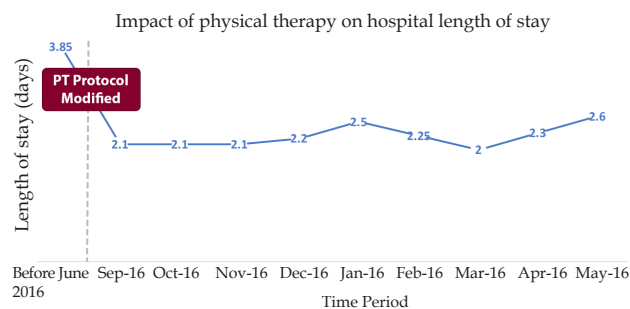


Figure 1 Timeline showing the difference in average hospital length of stay before and after implementation of an intensive physical therapy protocol. PT: Physical therapy.

patients after TKA^[17]. However, there are few studies in the current literature that describe the role of same-day and more frequent PT protocols in decreasing LOS for patients. To the contrary, Karim, *et al* found that PT protocols initiated on POD 0 provided no statistically significant benefit in decreasing LOS, as compared to our study which did find a decrease in LOS^[15]. This may be due to a multitude of factors such as differing patient demographics and PT protocols utilized for TKA patients between the two studies. Furthermore, it is unclear if they utilized identical PT protocols for both their TKA and THA patients, respectively. Thus, our study appears to be one of the first to exemplify how a rigorous PT protocol can decrease LOS among TKA candidates.

The PT protocol that we initiated for the intensive cohort (PT on POD 0, and twice a day sessions) eliminated the use of the continuous passive motion (CPM) machine, as compared to the non-intensive protocol. The CPM machine functions to passively and repeatedly move the knee through a specified range of motion^[18]. A recent Cochrane review found that the use of the CPM machine did not have clinically important effects on knee range of motion, function, or overall quality of life. For these reasons, when we devised our novel PT protocol we removed the CPM machine as a component of the protocol. Instead, we replaced the CPM machine with physical therapist active-assisted knee flexion and extension. Additional differences between our intensive and non-intensive regimens can be found in Table 1.

Another impact of the initiation of the new intensive PT program was that patients were less likely to be discharged to rehabilitation facilities and were more likely to be discharged back home. We found that 90.2% of patients undergoing the intensive PT protocol were discharged home, as compared to only 75.5% of patients who participated in non-intensive PT protocol ($p < 0.03$). Although these values are substantially higher than those reported in other studies, they demonstrate similar outcomes—rigorous postoperative PT enables patients to be discharged home sooner^[19]. Additionally, Brennan *et al*^[20] found that patients who were discharged home and who started outpatient PT sooner had better outcomes when compared to patients who waited longer to start outpatient PT following discharge. Thus, our PT rehabilitation protocol functions to decrease LOS, increase home discharge, and further highlights the importance of PT in the overall rehabilitation of patients following TKA.

Lastly, we did not find a significant difference in postoperative complication, 90-day emergency department (ED) visits, and 90-day readmission rates for the non-intensive and intensive PT protocols, as seen in Table 4. This is particularly important and timely as the U.S. Centers for Medicare and Medicaid services initiated mandatory 90-day bundle payments for TKA in 2016^[21]. Hospitals

are tasked with covering the cost for all patient readmissions within 90-days following TKA in Medicare and Medicaid patients. Given that a majority of patients in our public hospital system fall into this insurance group, decreasing cost incurred to the hospital is of the utmost importance. We found that initiating an intense PT protocol on POD 0 reduced the LOS and had no clinically significant influence on readmission rates thereby reducing the healthcare burden.

Our study is not without limitations. One limitation of our study is inherent to its retrospective design, potentially exposing the study to collection error. In order to minimize such errors, trained researchers collected data from our institution's electronic medical record. Another limitation of this study is the lack of validated patient reported outcomes (PROs) such as Knee Injury and Osteoarthritis Outcomes Scores (KOOS) pre- and postoperatively. However, this is impractical due to the underserved patient population included in this study. Despite these limitations, our study clearly establishes that robust PT with a trained clinician may significantly reduce LOS while enhancing the quality of care the TKA recipient receives.

CONCLUSION

The number of TKA cases to be performed annually is projected to increase to 3.5 million by 2030^[2]. Accompanying this exponential growth will be a greater focus on healthcare system cost and overall patient outcomes. One method by which the two aforementioned foci can be improved is through decreased LOS by initiating intensive PT protocols on POD 0 after TKA. In this study, we found that an intensive PT regimen significantly decreased LOS and increased home discharge for patients after TKA without negatively affecting postoperative clinical outcomes. Further studies will be required to analyze the long-term outcomes for these types of patients and discuss other methods by which protocols may be developed to decrease the overall cost burden to our ever-changing healthcare system.

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