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Pilot study

# Pilot study: Post-operative rehabilitation pathway changes and implementation of functional closed kinetic chain exercise in total hip and total knee replacement patient

C. Abbas [a], J. Daher [b, *]

[a] Windsor Regional Hospital Ouellette Campus, Windsor, Ontario, Canada
[b] Advanced Wellness Centre, Leamington, Ontario, Canada

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ABSTRACT

*Objective:* The aim of this study was to assess the feasibility of introducing a functional closed kinetic chain exercise program to an acute care setting to reduce length of hospital stay and assess tolerance to exercise immediately following total hip or total knee arthroplasty.
*Methods:* A protocol change implementing a functional closed kinetic chain based exercise program, post total hip (n = 535) and total knee (n = 695) arthroplasty, was performed at Windsor Regional Hospital Ouellette Campus in Windsor, Ontario Canada. A chart review was performed to compare the length of stay, post-surgery, of the new protocol to the length of stay of the previous range of motion and open kinetic chain based protocols of the previous two years.
*Results:* A significant (P-value <0.05) number of total hip and total knee arthroplasty patients reduced the length of hospital stay to less than 4 days using the closed kinetic chain program.
*Conclusion:* Evidence suggests that closed kinetic chain exercises are tolerated in the acute care setting and may be useful in reducing hospital length of stay post total hip and total knee arthroplasty.


## 1. Introduction

Ontario acute care hospital facilities have had increasing demands in the recent years which have led to a daily shortage in hospital beds. This has resulted in numerous elective surgery cancellations in order to support acute care medical concerns. Elective total hip and knee arthroplasties are among the most common cancelled surgeries to accommodate this shortage. At Windsor Regional Hospital Ouellette Campus (WRHOC), the total hip replacement (THR) and total knee replacement (TKR) surgical pathways had consisted of 4 days, where the day of surgery was considered post-operative day (POD) 0 and day of discharge (DOD) was expected to be POD 4. Thus, the elective post-operative patient was holding an acute care bed for approximately 4 days. Other than acute post-operative medical concerns, this length of stay was primarily dependent on the patient's need to achieve specific physical therapy goals prior to discharge; especially when elective surgical patients had no acute medical concerns prior to surgery. Moreover, the hospital's daily costs associated with an acute care patient was significant enough, where the hospital would largely benefit from decreasing the length of stay for post-operative elective surgeries.

Once a post-operative elective THR and TKR surgical patient has been medically cleared by their surgeon, their discharge is dependent on the physical therapist's determination of safe return to home. The required goals upon discharge include; independent bed mobility, independent transfers and gait and stair mobility, with respect to their functional need at home. Patients are also required to have a good understanding of their self-directed exercises. In addition, most TKR patients must achieve a minimal range of motion (ROM) of the post-operative knee of 90° of knee flexion and 0° of knee extension. Therefore, discharge of the THR and TKR patients are dependent on physical therapy goals, and the faster these goals were achieved dictated the culmination of the pathway and the release of an occupied acute care bed. The goal to improve post-operative physical therapy and decrease length of stay, while maintaining functional discharge criteria, would ultimately decrease the post-operative pathway for THR and TKR length of stay.

The current clinical pathway with respect to physical therapy

* Corresponding author.
*E-mail address:* josephdaherdc@hotmail.com (J. Daher).

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began on POD 1, where the therapist trained the patients on safe independent bed mobility, transfers and gait. The patients were educated on ankle dorsiflexion and plantar flexion circulation exercises to prevent blood clots. Patients were also educated on bed exercises completed in supine. THR exercises included static Quadriceps contraction, static Gluteus Maximus contraction, hip and knee flexion and hip abduction, while complying with the post-operative hip precautions. TKR patients completed knee ROM on a knee slider board, after 20 min of ice and concluded with a ROM measurement. TKR patients also completed static quadriceps contraction, quadriceps over roll knee extension and straight leg raise. On POD 2–3, patients continued with bed mobility, transfers and gait training. The physical therapist progressed the patients' gait aids, as required and increased repetitions of their bed exercises. On POD 4, patients were educated on stair climbing, if it was required for home mobility. If patients demonstrated independent and safe mobility and knee ROM requirements were met, they were discharged from physical therapy; and if medically cleared, were able to return home.

The current post-operative protocol had many limitations. Primarily, it does not correlate with trends in evolving rehabilitation evidence. In addition to its daily non-progressive repetitive treatment, the post-operative exercises were non-functional and based on open kinetic chain movements. Open kinetic chain (OKC) exercises allow the distal limb to move freely and are not considered a functionally based exercise due to the lack of similarity to daily movements. This rehabilitation technique was specific to isolate joints or muscle groups and focused on concentric muscle contraction training. OKC exercises were traditionally incorporated in post THR and TKR rehabilitation due to the thought that these exercises were minimally aggressive for the new joint and decreased the load on the joint. However, OKC exercises may lead to many overlooked musculoskeletal issues as well as increased shear forces through the newly replaced joint. *'Analysis of tibiofemoral compression forces and electromyographic recruitment patterns revealed that the closed-kinetic-chain exercise produced significantly greater compression forces and increased muscular co-contraction at the same angles at which the open-kinetic-chain exercises produced maximum shear forces and minimum muscular co-contraction.'* (Lutz et al., 1993) Aside from the increased forces placed upon the joint, the lack of inherent functionally based movements performed by these exercises may have left patients with deficits post THR and TKR rehabilitation.

Research on THR and post replacement deficits revealed that, '*bed exercises were of no additional benefit to early mobilization after THR*' (Roos, 2003). In addition, surgical incision and pain caused by TKR inhibits the Quadriceps Vastus Medialis, a primary medial knee and patella stabilizer (Chmielewhi et al., 2004). Both muscles groups remain inhibited without proper activation and training, post THR and TKR. *'Quadriceps strength is related to functional performance and it is the single greatest predictor of function'* (Petterson et al., 2009; Mizner et al., 2005). *Following a TKR surgery, there is 'a mean extension strength loss of 80% and this loss is directly correlated to functional performance'* (Jakobsen et al., 2012). Quadriceps weakness would further decline with non-functional exercise, such as OKC. Furthermore, following TKR surgery, patients have exhibited lower extremity asymmetry for functional movements. Despite the testing conditions or time post-surgery, strength and load bearing asymmetry existed between affected and unaffected side. Patients are 'relying *on their unaffected side for completion of functional tasks*' (Rossi and Hanson 2004, Rossi et al., 2010).

During the design phase of this study, a telephone survey was conducted to major acute care hospitals in Ontario, which revealed the common post-operative exercise was OKC for THR and TKR surgeries. As OKC exercise is the current standard for post THR and TKR rehabilitation, a lack of functionality and activation of inhibited musculature has been noted, causing the aforementioned functional deficits. This is a traditional method of exercise and not an evidence based method of post joint replacement rehabilitation.

Closed kinetic chain (CKC) exercises fixate the distal portion of the limb, producing multi-joint and multi-muscle therapy. CKC exercises mimic commonly used movements and are considered functional exercise. According to Stensdotter et al. (2003), CKC exercises have many benefits. CKC produce co-contraction around the joint, increasing joint stability. These benefits, in reference to THR and TKR rehabilitation, seem to outweigh those of OKC regarding stabilization, functionality and muscular strength progression.

The current post-operative protocol had no CKC exercise to achieve the required post-surgical hospital discharge mobility goals: bed mobility, transfers, gait and stair training. Research has supported that after a TKR, the most difficult tasks to complete require '*entire lower limb force production*,' such as stair climbing and sit-stands (Jones et al., 2003; Rossi and Hanson 2004, Rossi et al., 2006, 2010; Walsh et al., 1998; Whitehouse et al., 2003). These are all closed kinetic chain tasks that should be trained with CKC functional specific rehabilitation (Rossi et al., 2010). In addition, the protocol had no functional progressions, besides increasing repetitions. Stair training was only initiated on the expected day of discharge, leaving no room for continued training. Furthermore, higher intensity exercise had been limited due to fear of prosthesis failure, which may have led to greater length of stay. Jakobsen et al. (2012) showed that patients can tolerate an intense progressive strengthening program 1–2 days follow TKR, without affecting ROM and while producing increased isometric knee extension strength by 147%, increased maximal walking speed by 112%, while maintained pain levels at mild to moderate during and after exercises. Therefore, *'progressive strength training initiated immediately after TKA is feasible and increases knee extension strength and functional performance without increasing knee joint effusion or knee pain'* (Jakobsen et al., 2012). These results seem to dispel the common myths that post-surgical patients cannot tolerate intensive post-operative exercise program. Roos, (2003), found that even elderly patients with co-morbidities can tolerate *'early intensive rehabilitation.'* In fact, exercises can start as early as in the recovery room (Andersen et al., 2008).

The need for an abbreviated pathway, including progressive functional based CKC exercise was determined. The goal of this analysis was to identify if a higher intensity, abbreviated CKC rehabilitation program could produce shorter length of stay, with the same discharge criteria, while introducing a functional based exercise program to elective THR and TKR patients.

## 2. Method

A change in hospital protocol was designed to implement a new rehabilitation pathway for post-surgical THR and TKR patients at WRHOC, in order to: decrease length of stay and promote increased functionality for the patients at DOD without modifying patients' discharge criteria. . Due to limitations in resources and time in the acute care setting, more than one sample group could not be tested consecutively. All subjects that received a TKR ($n = 381$) and THR ($n = 274$) at WRHOC in 2013, were subject to the new rehabilitation protocol and data collected underwent a chart review, comparing the DOD of the average number of TKR ($n = 314$) and THR ($n = 261$) from 2011 to 2012.

The new post-operative rehabilitation pathway (NPORP) was chosen to incorporate functionally based exercises. The functionally specific CKC exercises were geared towards helping patients meet their discharge mobility goals of independent bed mobility,

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