

Manual Physical Therapy for a Patient Following Total Knee Arthroplasty

Submitted in Partial Fulfillment of the Requirements for the  
Doctor of Physical Therapy research project

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## **ABSTRACT**

**TITLE:** Manual Physical Therapy for a Patient Following Total Knee Arthroplasty (TKA).

**STUDY DESIGN:** Prospective case study.

**PUPOSE:** The purpose of this case study was to describe the effect of adding manual therapy to standard physical therapy on changes in ROM, functional performance, and self-reported measures of function following TKA.

**BACKGROUND:** One understudied area of rehabilitation following TKA is manual physical therapy. Manual physical therapy is the manipulation of body tissue, such as muscles and joints, using one's hands. Manual physical therapy techniques include massage, assisted stretching, and traction applied to the joints. While the effect of manual therapy combined with exercise has been investigated for other musculoskeletal problems such as neck pain, low back pain, and cervicogenic headaches, less evidence exists for knee dysfunction.

**CASE DESCRIPTION:** A 66-year-old woman was referred to outpatient physical therapy 3 weeks following primary unilateral TKA for severe osteoarthritis. Upon initial examination, the patient had significant post-operative pain, impaired gait, and decreased range of motion (ROM), strength, and functional mobility. Additionally, the patient presented with adherent scar tissue along the length of her surgical incision and diffuse soft tissue restrictions in the quadriceps and tensor fascia latae. Treatment consisted of all the components of conventional physical therapy in addition to manual physical therapy. Components of traditional physical therapy included strengthening exercises, aerobic exercises, stretching, and training in performance of everyday activities, such as navigating stairs. Manual therapy techniques included joint mobilization, scar tissue massage, soft tissue mobilization, and therapist-assisted manual stretching. Active knee flexion ROM, the Timed Up and Go (TUG), the 6 Minute Walk Test (6MW), and the 36-Item Short Form Health Questionnaire (SF-36) were completed at initial examination and again 5 weeks later at discharge.

**OUTCOMES:** Scores achieved on the TUG, 6MWT, and active knee flexion ROM exceeded those achieved by patients who participated in a standardized rehabilitation program following TKA that did not include manual therapy despite those patients being evaluated one month further out from surgery.

**DISCUSSION:** The addition of manual physical therapy to exercise, stretching, and functional activity training as described in this case study were effective in improving active knee flexion ROM and performance on 2 test of functional mobility (TUG and 6MWT) for this patient following primary unilateral TKA. These results are consistent with those reported in a case series investigating the effectiveness of manual physical therapy combined with exercise following TKA in which improvements in function and ambulation equaled or exceeded those previously reported in the literature.

## INTRODUCTION

Knee osteoarthritis (OA) is a degenerative process resulting in joint pain and stiffness, motor and sensory dysfunctions, limitations in motion, and functional impairments (Goodman and Fuller, 2008). Those with knee OA often have difficulty performing everyday tasks such as bathing, dressing, cleaning, kneeling, and using stairs (Noble, Gordon, Weiss, Reddix, Conditt, and Mathis, 2005). An estimated 10% to 15% of older adults develop knee OA (Hill, Gale, Chaisson, Skinner, Kazis, Gale, et al, 2003). When conservative measures such as exercise, weight loss, and medications fail to adequately reduce pain, many patients elect to undergo total knee arthroplasty (TKA), of which more than 650,000 were performed in 2009 (Agency for Healthcare Research and Quality, 2009). TKA has reliably shown to reduce pain and improve health-related quality of life in 90% of patients. Yet despite a patient satisfaction rate of 85% (NIH, 2003), deficits in strength, range of motion, and functional abilities still persist following TKA (Bade, Kohrt, and Stevens-Lapsley, 2010; Noble, et al, 2005). Moreover, several studies have found a significant discrepancy between subjective and objective determinants of function following TKA (Jacobs and Christensen, 2009; Mizner, Clements, Petterson, and Snyder-Mackler, 2005a; Mizner, Petterson, Clements, Zeni, Irrgang, and Snyder-Mackler, 2011). Self-reported measures of function both failed to capture the dramatic decrease in function demonstrated during performance-based tests one month following TKA and significantly overestimated the degree of improvement one year following TKA (Mizner, et al, 2011). While most patients are able to return to the same level of function experienced prior to TKA, studies have consistently shown that functional parameters including strength, endurance, and mobility

fall well below those achieved by age- and gender-matched peers (Bade, et al, 2010; Noble, et al, 2005; Walsh, Woodhouse, Thomas, and Finch, 1998).

Physical therapy following TKA aims at reversing these deficits and focuses on pain reduction, strengthening, normalization of gait pattern, and maximization of ROM and functional performance (Cademartiri and Soncini, 2004; Dutton, 2008). However, there is a lack of consensus and a paucity of evidence-based research regarding the most effective rehabilitation approach following TKA, especially in the outpatient setting (NIH, 2003). Recent research on post-surgical rehabilitation has focused on more intensive exercise programs aimed at eliminating the functional performance gap between TKA patients and their healthy cohorts. Results from these studies reveal a more rapid return to activity and better outcomes on performance-related tasks compared to those programs employing a more traditional rehabilitative approach (Meier, Mizner, Marcus, Dibble, Reters, and Lastayo, 2008; Mizner, Petterson, and Snyder-Mackler, 2005b; Moffet, Collet, Shapiro, Paradis, Marquis, and Roy, 2004; Petterson, Mizner, Stevens, Rasis, Bodenstab, Newcomb, et al, 2009; Yoshida, Mizner, Ramsey, and Snyder-Mackler, 2008). Yet outside this more progressive approach, current rehabilitative strategies following TKA have failed to maximize function.

One understudied area of rehabilitation following TKA is manual physical therapy. Manual physical therapy is the manipulation of body tissue, such as muscles and joints, using one's hands. Manual physical therapy techniques include massage, assisted stretching, and traction applied to the joints. While the effect of manual therapy combined with exercise has been investigated for other musculoskeletal problems such as neck pain (Walker, Boyles, Young, Strunce, Garber, Whitman, et al, 2008), shoulder impingement (Senbursa, Baltaci, and Atay, 2007), low back pain (Childs, Fritz, Flynn, Irrgang, Johnson, Majkowski, et al, 2004), and cervicogenic headaches (Jull, Trott, Potter, Zito, Niere, Shirley, et al, 2002), less evidence exists for knee dysfunction. Though the evidence may be limited, results consistently favor the addition of manual therapy to exercise when treating knee dysfunction. Some of the most promising results have come from studies of patients with knee OA (Deyle, Allison, Matekel, Ryder, Stang, Gohdes, et al, 2005).

Because strength and functional deficits attributed to knee OA do not spontaneously resolve following TKA, there is a strong theoretical basis for the use of manual physical therapy following TKA. Additionally, when considering the decreased ROM and functional

performance following the standard medial parapatellar approach compared to minimally invasive surgical approaches, the effects of the surgical approach itself, namely disruption of the quadriceps tendon and other soft tissue structures (Bonutti, Zywiell, Seyler, Lee, McGrath, Marker, et al, 2010; Dai, Yu, Wu, He, Wang, and Yang, 2008; Haas, Cook, and Beksac, 2004; Majima, Nishiike, Sawaguchi, Susuda, and Minami, 2011), present a valid case for the use of manual therapy techniques. One unpublished case series examining the addition of manual physical therapy to exercise during outpatient rehabilitation after TKA resulted in significant functional improvements on the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and TUG scores equal to or better than age-matched healthy adults (Smith and Boyles, 2006). And even when administered as the sole intervention, manual therapy has been shown to significantly reduce pain and improve function for a variety of knee problems including patellafemoral/anterior knee pain (Hains and Hains, 2006; Van den Dolder and Roberts, 2006), patellar tendonopathy (Pedrelli, Stecco, and Day, 2009), and knee osteoarthritis (Pollard, Ward, Hosking, and Hardy, 2008) when compared to a control group.

The purpose of this study was to describe the effect of adding manual therapy to standard physical therapy on changes in ROM, functional performance, and self-reported measures of function following TKA. Investigating alternative approaches such as manual physical therapy will help in determining the best combination of interventions to provide patients during the course of their rehabilitation.

## **METHODS**

### **Research Design**

This case study describes the use of manual physical therapy techniques for a 66-year-old woman following TKA during the course of a pilot study designed to investigate the effects of manual therapy on functional performance and self-reported function following TKA. The pilot study was designed as a one-group pretest-posttest quasi-experiment to involve 15 subjects. The study was approved by the Georgia Health Sciences University (GHSU) institutional review board. Informed consent was obtained from the patient described in this case study. *See Appendix A for the Description of Research Proposal and Attachment A for the Informed Consent Document.*

## Subjects

A sample size analysis using an alpha = 0.05 and power = 80% showed that 13 subjects would be sufficient to test the hypothesis that subjects would improve their scores on a performance-based test (the Timed Up and Go) between the first and last treatment session by at least 5%. A total of 15 subjects was set as the target sample size in anticipation of dropouts. To date, 3 subjects have been recruited. The first subject developed pulmonary emboli and, per the study protocol, was dis-enrolled from further participation in the study. Complete data exists for the second subject, on whom the case study which follows is based. The third subject has not yet met the minimum visit requirement for completion of the study. Recruitment of prospective subjects will continue throughout this year or until 15 subjects have been enrolled in the study, whichever comes first. The following criteria were established for participation in the pilot study:

### Inclusion criteria:

- Underwent elective primary unilateral TKA for end-stage osteoarthritis within the 4 weeks prior to enrollment in the study
- Between the ages of 50 and 85 years
- Able to follow a home exercise program (HEP) independently
- Ambulatory with or without a walking aid prior to TKA
- Medical clearance from the subject's surgeon to receive manual therapy

### Exclusion criteria:

- Hemiarthroplasty, revision arthroplasty, or emergency arthroplasty
- Previous unicompartmental replacement or tibial osteotomy on the same knee
- Knee infection or other major complications following TKA
- Rheumatoid arthritis
- Uncontrolled hypertension, defined as systolic blood pressure  $\geq$  200 mmHg, diastolic blood pressure  $\geq$  100 mmHg, symptomatic elevation in blood pressure, or exceeding subject-specific blood pressure parameters established by physician orders
- An associated condition impeding performance of locomotor tests, including significant contralateral knee OA (defined by pain with activity greater than 4/10 on a verbal pain scale)
- Body Mass Index (BMI) greater than 40 kg/m<sup>2</sup>
- Other lower limb joint replacement surgery expected within 6 months
- Resident of a long-term care facility
- Resided more than 35 miles beyond the clinic
- Use of a minimally invasive surgical approach
- Those for whom manual therapy was contraindicated

## **CASE DESCRIPTION**

### **Patient**

A 66-year-old woman was referred to outpatient physical therapy 3 weeks following primary TKA of the right knee for severe osteoarthritis. The patient reported a long history of knee pain (since 1998), which intensified in the past year to the point where she opted to have knee replacement surgery. Although the patient did not use an assistive device for ambulation prior to TKA, she reported limiting her ambulation due to knee pain. During the initial examination, the patient rated the current pain level in her unoperated (left) knee as 0/10 (numeric pain rating scale) both at rest and during activities of daily living (ADLs). Review of the patient's medical history revealed the following co-morbidities: hypertension, high cholesterol, asthma, sleep apnea, diabetes, depression, and arthritis. Additionally, the patient's right ankle had previously been stabilized with an internal fixator, which remained in place. Health habits of note included using 1 can of tobacco per week. At a height of 61 inches and a weight of 191 pounds, the patient's body mass index (BMI) was calculated as  $37.2 \text{ kg/m}^2$ . As a participant in the pilot study, the patient met the afore-mentioned inclusion and exclusion criteria. Despite the patient's history of hypertension, results from blood pressure monitoring during the initial session indicated that she was appropriate for participating in the study.

### **Examination**

Upon initial examination, the patient had significant post-operative pain, impaired gait, and decreased range of motion (ROM), strength, and functional mobility. Additionally, the patient presented with adherent scar tissue along the length of her surgical incision and diffuse soft tissue restrictions in the quadriceps and tensor fascia latae. Two myofascial trigger points were located in her lateral quadriceps. A trigger point is a small, hard knot within the soft tissue that causes pain when stimulated. The outcome measures listed below were administered during the initial examination.

### **Outcome Measures**

Due to the significant discrepancy in results between self-reported measures of function and performance-based tests following TKA (Jacobs, et al, 2009; Mizner, et al, 2011; Mizner, et al, 2005a), both subjective and objective measures of function were utilized in this study. Performance-based tests – the Timed Up and Go Test (TUG), the 6 Minute Walk Test (6MW), and active range of motion (AROM) for knee flexion – were utilized in this study as the primary outcome measures. And because it is important to capture the patient’s perception of improvement, a self-reported measure of function – the physical component summary of the 36-Item Short Form Health Questionnaire (SF-36) – was utilized as a secondary outcome measure.

**TUG:** The TUG assesses functional mobility and has been used to evaluate gait and balance disorders in the elderly (American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons, 2001; Bohannon, 2006). The TUG measures, in seconds, the time taken by an individual to stand up from a standard arm chair, walk a distance of 3 meters, turn, walk back to the chair, and sit down (Mathias, Nayak, and Isaacs, 1986; Podsiadlo and Richardson, 1991). The patient performed one trial run, after which the average of two test runs was recorded as her score. Podsiadlo and Richardson reported good intertester and intratester reliability ( $ICC = 0.99$ ) as did Steffen et al. ( $ICC_{2,1} = .95 - .97$ ) (Steffen, Hacker, and Mollinger, 2002). The TUG has been used in several studies measuring outcomes following TKA (Kennedy, Stratford, Wessel, Gollish, and Penney, 2005; Mizner, et al, 2005b; Petterson, et al, 2009; Rossi, Eberle, Roche, Waggoner, Blake, Burwell, et al, 2009).

**6MW:** The 6MW assesses functional exercise capacity and serves as an indicator of one’s ability to perform daily activities. The 6MW measures the distance an individual covers over a hard, flat surface in 6 minutes. During the test, the patient is encouraged to walk as far as possible within the 6 minutes, with permission given to stop and rest as needed (American Thoracic Society, 2002). Upon expiration of 6 minutes, the tester measures the distance covered in meters. The American Thoracic Society recommends use of a straight 30-meter corridor in which to conduct the test; however, due to the constraints of the facility in which this study’s patient was assessed and treated, an oval track measuring 110 feet (33.5 meters) was used. High test-retest reliability ( $ICC_{2,1} = .94 - .97$ ) has been reported in several studies (Enright, 2003; Kennedy, et al, 2005; Steffen, et al.,2002). Several studies have utilized the 6MW to assess

changes in functional mobility following TKA (Kreibich, Vaz, Bourne, Rorabeck, Kim, Hardie, et al, 1996; Parent and Moffet, 2002). Parent and Moffet ranked the 6MW as the most responsive locomotor test for monitoring early recovery after TKA.

**AROM:** AROM for knee flexion was selected as a primary outcome measure due to the deficits in knee motion following TKA and the resultant limitations in performance of functional activities, such as stair-ascent and chair sitting. In order to permit comparison of AROM values reported in earlier studies (Bade, et al, 2010; Kramer, Speechley, Bourne, Rorabeck, and Vaz, 2003; Rajan, Pack, Jackson, Gillies, and Asirvatham, 2004), knee flexion was measured with the patient in the seated position, permitting flexion at the hip. The patient was asked to maximally flex her knee toward the buttocks. A universal goniometer was used to measure AROM. The greater trochanter and the lateral malleolus were used to align the proximal and distal ends of the goniometer, respectively, while the midline of the knee joint was used to align the axis. Intratester reliability for knee flexion AROM has been reported as 0.97 for experienced testers and 0.96 for inexperienced testers evaluating patients following TKA (Jakobsen, Christensen, Christensen, Olsen, and Bandholm, 2010).

**SF-36:** The Medical Outcomes Study 36-item short-form health survey (SF-36) is the most commonly used health-related quality of life instrument in studies investigating joint replacement (Ethgen, Bruyère, Richy, Dardennes, and Reginster, 2004). The most recent version of the SF-36 – the SF-36v2 – was used in this study. The SF-36v2 contains 36 questions covering the following eight health dimensions: physical function, bodily pain, role physical, general health, vitality, role emotional, social function, and mental health. These eight dimensions are combined to form two summary measures: the physical component summary (PCS) and the mental component summary (MCS). The PCS and MCS are norm-based scores where an average of 50 and a standard deviation of 10 represent the average of the general US population (Ware, Kosinski, and Gandek, 2002). Only the PCS was computed and used for this study. The SF-36 was selected for use in this study due its reliability and ease of administration (Brazier, Harper, Munro, Walters, and Snaith, 1999).

## **Evaluation/Diagnosis**

According to the examination results, the patient significantly lagged behind on the post-operative TKA protocol in terms of ROM and strength. Her problem list consisted of post-operative pain, impaired gait, and decreased ROM, strength, and functional mobility. In addition to right TKA due to osteoarthritis and impaired gait, the physical therapy diagnosis included myofascial pain and restrictions with active trigger points.

### **Procedures**

The patient received outpatient physical therapy 2-3 times per week over the course of 5 weeks for a total of 11 sessions. Although it was intended for the patient to receive between 12 and 18 sessions over the course of 6 weeks, fewer sessions were permitted (as was delineated in the study protocol) owing to the fact that she had met all of her rehabilitation goals by the eleventh session. Each therapy session lasted approximately 45 minutes. All outcome measures were assessed by the same physical therapist at the first and last treatment sessions.

## **INTERVENTION**

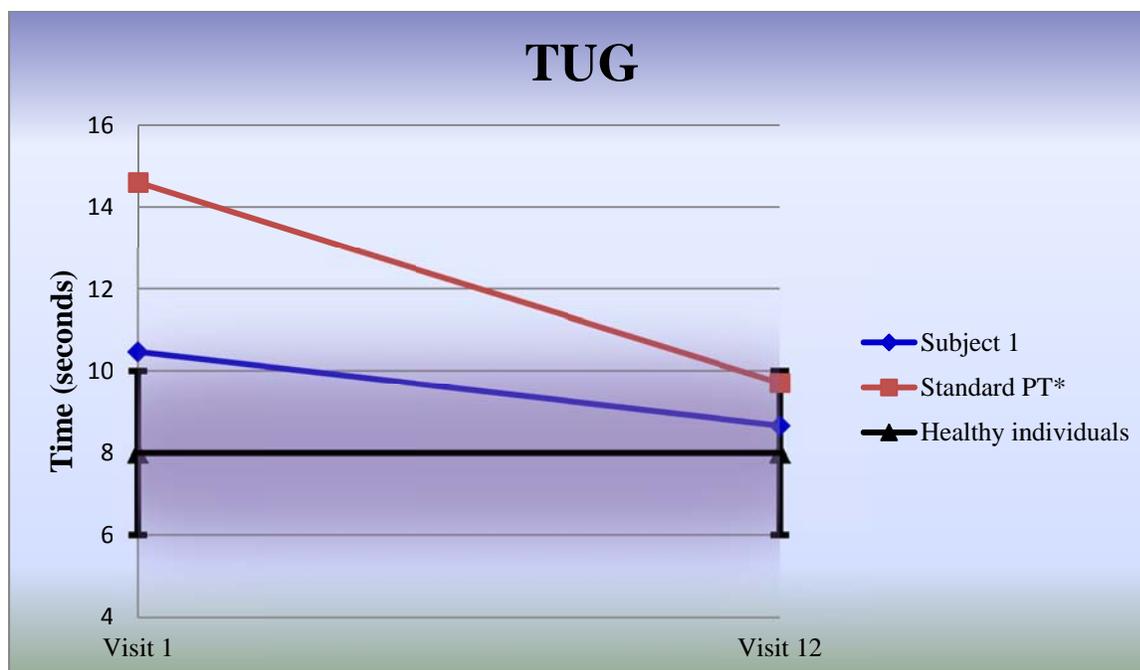
Treatment consisted of all the components of conventional physical therapy in addition to manual physical therapy. Components of traditional physical therapy included strengthening exercises, aerobic exercises, stretching, and training in performance of everyday activities, such as navigating stairs and ambulation. If needed to control for pain and/or swelling, a cold pack was applied to the knee joint following the treatment session. Manual therapy techniques included joint mobilizations, scar tissue massage, soft tissue mobilization, and therapist-assisted manual stretching. The physical therapist who administered all outcome measures also delivered all treatment and at the time of the study had 15 years of experience utilizing the aforementioned interventions. Each treatment session was approached from an impairment-based model, with the physical therapist making adjustments in the delivery of interventions (i.e. amount of time, intensity, etc.) according to the needs of the patient. All treatment sessions began with an 8 to 10 minute warm-up on the stationary recumbent bicycle to increase blood flow to and extensibility of the muscles surrounding the knee joint. This was followed by manual therapy techniques, the duration of which generally decreased throughout the patient's course of therapy, as fewer adhesions within the muscles, fascia, and surgical scar were noted each passing week. Soft tissue mobilization was performed on the muscles surrounding the knee

joint (most often to the rectus femoris and vastus lateralis), and ischemic compression was applied to trigger points located on the lateral and anterior aspects of the thigh. Because the surgical dressing had already been removed from the patient's incision site prior to initiation of her treatment, cross fiber friction was administered along the surgical scar to break up adhesions and enable the skin to glide freely over the underlying soft tissue from the very first session. To further increase knee joint mobility, mobilizations to the patellafemoral and tibiofemoral joints were performed. Stretching of the lower extremity muscles – predominantly of the quadriceps and hamstrings – was conducted both independently by the patient and with overpressure applied by the physical therapist. Strengthening exercises were aimed primarily at increasing strength in the quadriceps and, to a lesser extent, the hip muscles. Strengthening exercises targeting the quadriceps progressed from open-chain exercises such as quad sets and short-arc-quads to closed-chain exercises such as step-ups and mini squats. During the latter half of the patient's therapy course, training in functional activities such as stair climbing took place. Additionally, the patient was given a home exercise program to be performed on non-treatment days that consisted of stretches and exercises that replicated or approximated those done during therapy sessions.

## **OUTCOMES**

### **TUG**

The patient decreased her time on the TUG from 10.5 seconds at the first session to 8.7 seconds at the last session – a reduction of almost 2 seconds (**TABLE 1**). The patient's pre-treatment and post-treatment results are plotted on a graph for visual comparison against results achieved by 24 subjects (age = 65.0 years  $\pm$  6.5) who received on average 11.5 sessions of standard physical therapy (PT) (**TABLE 2**). The patient's results are also plotted against results achieved by 22 age- and gender-matched community-dwelling adults with no reported joint pain (**TABLE 3**). Visual analysis shows that while both the patient described in this case study and those subjects participating in a standard rehabilitation program fell within 1 standard deviation of normative data for the group of community-dwelling, gender-matched cohorts, the patient in this case study more closely approximated the normative mean, being just .65 seconds slower.

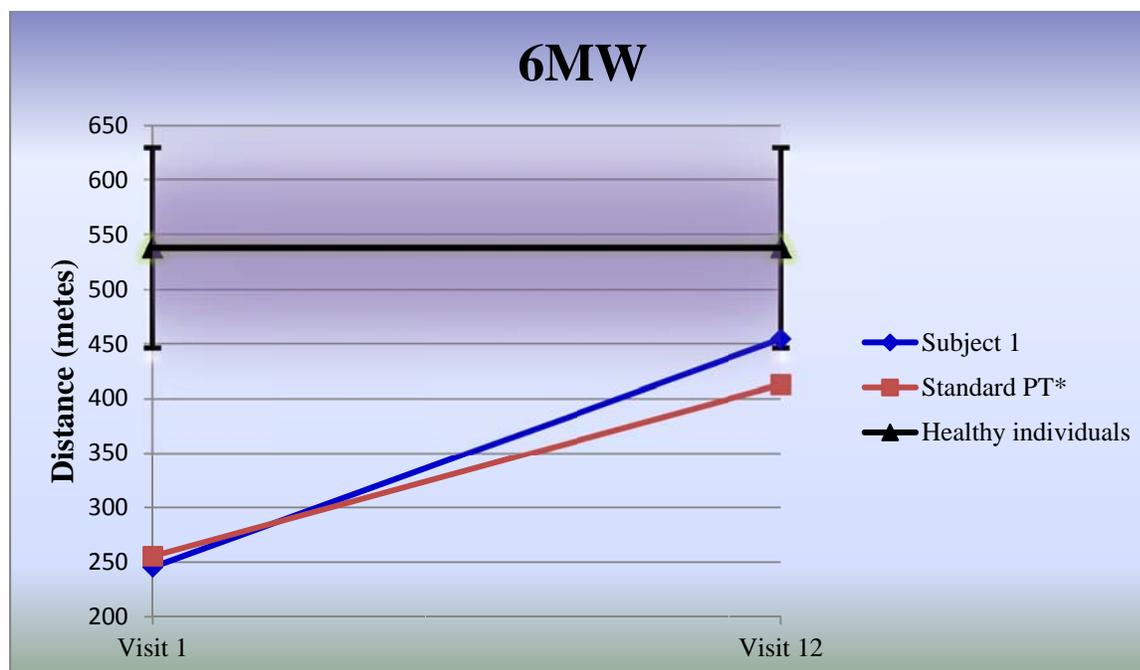


**Figure 1.** Abbreviations: TUG, Timed Up and Go; PT, Physical Therapy  
**TUG by subjects in both groups at initial and final examinations. Shaded area represents the mean performance ( $\pm 1$  SD) of 22 age-matched females (aged 60-69 years).**

\*Values for TUG were obtained from the results reported by Bade et al (2010) of 24 subjects following 11.5 sessions of standard PT.

## 6MW

By the last session, the patient nearly doubled the distance walked on the 6MW from 245 meters to 454 meters (**TABLE 1**). The patient's pre-intervention and post-intervention results are plotted on a graph and once again compared to subjects who received standard PT (**TABLE 2**) and to healthy gender-matched cohorts (**TABLE 3**) as was done when visually analyzing TUG results. For the 6MW, only the patient in this case study fell within 1 standard deviation of the normative data representing healthy gender-matched cohorts upon completion of her treatment despite performing more poorly on the initial assessment.



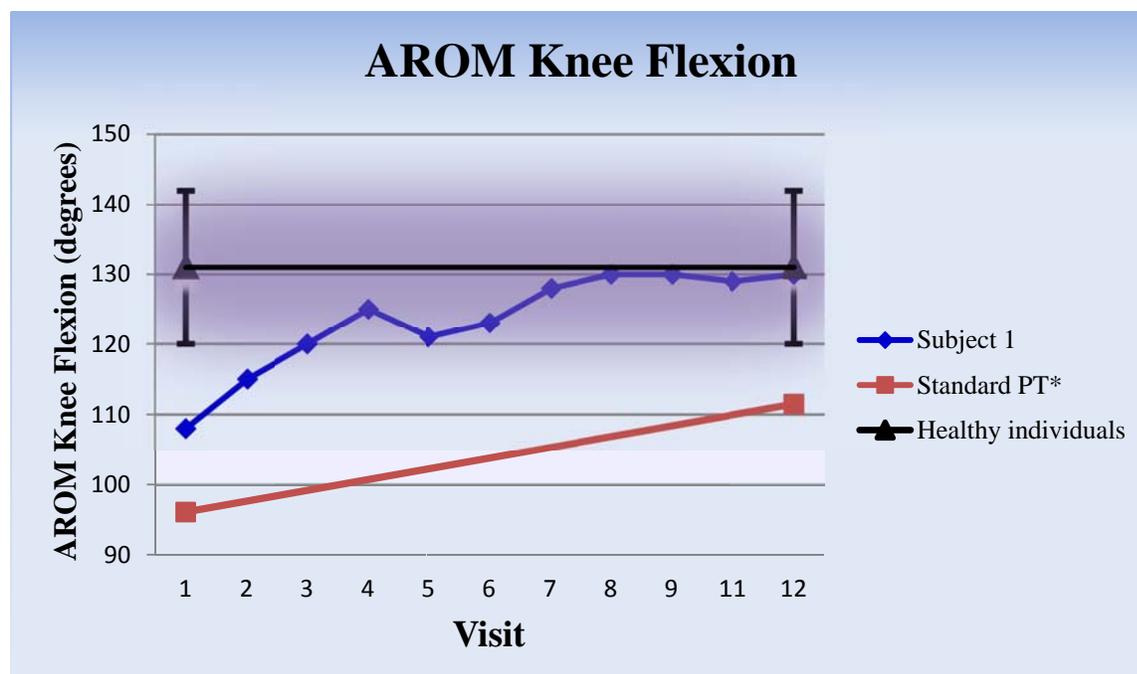
**Figure 2.** Abbreviations: 6MWT, 6 Minute Walk Test; PT, Physical Therapy  
**6MW by subjects in both groups at initial and final examinations. Shaded area represents the mean performance ( $\pm 1$  SD) of 22 age-matched females (aged 60-69 years).**

\*Values for 6MW were obtained from the results reported by Bade et al (2010) of 24 subjects following 11.5 sessions of standard PT.

## AROM

The patient increased knee flexion AROM 22 degrees by the 8<sup>th</sup> session to achieve 130 degrees, which was the upper limit set by her orthopedic surgeon. Because further increases in ROM may have placed unwanted stress on the artificial knee components, the physical therapist made no attempt to achieve further gains in knee flexion ROM. This increase in knee flexion AROM was maintained until discharge at the 11<sup>th</sup> visit. AROM values for all but the 10<sup>th</sup> session were recorded and are plotted on a graph and compared to results achieved by 24 subjects (age =  $65.0 \pm 6.5$ ) who received on average 11.5 sessions of standard PT (TABLE 2). The patient's results are also compared to results achieved by 523 community-dwelling individuals (aged 60-74 years) (TABLE 3), representing age-matched normative data. The patient fell just 1 degree shy of reaching the normative mean. However, as previously mentioned, further gains in ROM were not pursued in order to maintain the integrity of the artificial knee components. Visual inspection of the graph shows that those subjects who received standard PT lacked 20 degrees of

knee flexion AROM post-treatment compared to the age-matched normative mean, falling well outside 1 standard deviation.



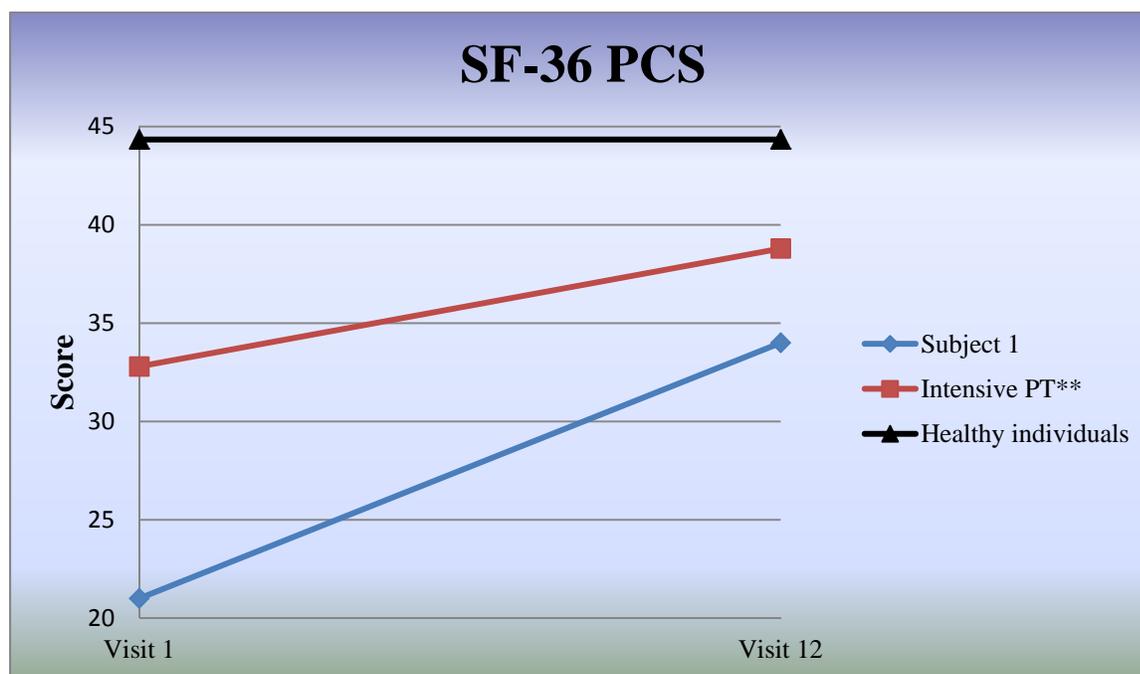
**Figure 3.** Abbreviations: AROM, active range of motion; PT, Physical Therapy  
**AROM for knee flexion by subjects in both groups at initial and final evaluations.**  
**Shaded area represents the mean performance ( $\pm 1$  SD) of a 523 age-matched, community-dwelling individuals (aged 60 - 74 years).**

\*Values for AROM knee flexion were obtained from the results reported by Bade et al (2010) of 24 subjects following 11.5 sessions of standard PT.

### SF-36 PCS

An improvement of 60% was made on the SF-36 PCS, with the patient increasing her score from 21 to 34 (TABLE 1). The patient's pre-treatment and post-treatment results are plotted on a graph for visual analysis against results achieved by 38 subjects (age =  $66.7 \pm 8.7$ ) who received 12 sessions of intensive functional rehabilitation following TKA (TABLE 2b). The patient's results are also plotted against results reported in the 1998 National Survey of Functional Health Status for females ranging in age from 65 to 74 years (TABLE 3), representing age- and gender-matched normative data. The SF-36 PCS is the one outcome measure for which the patient's post-treatment result fell below that of the group that received an alternate form of PT following TKA. However the comparison group for this outcome measure received intensive functional

rehabilitation rather than standard rehabilitation (unlike the previous comparison groups), and their rehabilitation was initiated (and consequentially completed) 2 months further out from surgery than was the patient in this case study. The intent of the delayed initiation of rehabilitation, according to the study's authors, was to allow more time for the reduction of edema and resolution of post-operative pain before implementation of an intensive exercise program. The patient in the case study documented "very severe" bodily pain and pain interfering with normal work "quite a bit" on the post-treatment assessment of the SF-36. Because pain significantly influences subjective reports of function, such as the SF-36 (Maly, Costigan, and Olney, 2006), it is important to note that the patient's high level of pain may have negatively impacted her perceived level of function (an unlikely factor for those patients in the comparison group). Yet despite the patient in this case study scoring less on the final assessment of the SF-36, she nonetheless improved her overall score by 13 points compared to a 6-point improvement reported for the comparison group.



**Figure 4.** Abbreviations: SF-36 PCS, 36-Item Short Form Health Questionnaire Physical Component Summary; PT, Physical Therapy  
**SF-36 PCS by subjects in both groups at initial and final examinations. Shaded area represents the mean performance of females aged 65-74 years reported by the 1998 National Survey of Function Health Status.**

\*\*Values for SF-36 PCS were obtained from the results reported by Moffet et al (2004) of 38 subjects following 12 sessions of intensive functional rehabilitation.

## DISCUSSION

There is a lack of consensus and a paucity of evidence-based research regarding the most effective rehabilitation approach following TKA, especially in the outpatient setting. Researchers have begun to explore more progressive and intensive strengthening programs following TKA, the results of which show significantly improved functional outcomes compared to standard of care physical therapy (Meier, et al, 2008; Mizner, et al, 2005b; Moffet, et al, 2004; Petterson, et al, 2009; Yoshida, et al, 2008). Yet outside this more progressive approach, current rehabilitative strategies following TKA have failed to maximize function. Those having undergone primary TKA consistently lag well behind healthy age-matched individuals in performance of everyday activities such as stair climbing and walking speed (Moffet, et al, 2004; Walsh, et al, 1998). The benefits of manual physical therapy in the rehabilitation of TKA remain largely unexplored, as there is only one case series that has investigated its use. The purpose of this case study was to describe the effect of adding manual therapy to standard physical therapy on changes in ROM, functional performance, and self-reported measures of function following TKA.

Several study parameters were controlled to facilitate comparison of results from this case study to studies investigating TKA outcomes following standard physical therapy in which manual therapy techniques were not utilized. Inclusion and exclusion criteria met by our patient are consistent with those established by these earlier studies as are details of the treatment delivery, such as the number of treatment sessions, length of individual sessions, and time since surgery upon initiation of treatment. Despite the addition of manual therapy techniques to the standard components of physical therapy such as exercise and stretching, each treatment session lasted no more than 45 minutes. Both the duration of individual treatment sessions and the total number of visits (11) fall within the range that would be delivered in an outpatient setting for a patient following TKA (DeJong, Tian, Smout, Horn, Putman, Smith, et al, 2009).

The patient described in this case study is representative of the typical patient who undergoes TKA. A systematic review of 62 studies listed the following characteristics of patients who had undergone primary TKA: average age was 67.5 years, two-thirds were female,

one-third were obese, and almost 90% had osteoarthritis (Kane, Saleh, Wilt, Bershadsky, Cross, MacDonald, et al, 2003). Our patient was a 66-year-old obese female with severe osteoarthritis.

Scores achieved by the patient in this case study on all 3 performance-based measures (TUG, 6MW, and knee flexion AROM) exceeded those achieved by subjects who participated in a standardized rehabilitation program following TKA that did not include manual therapy despite those patients being evaluated at least one month further out from surgery. When comparing the results in terms of percent improvement, the subjects who received standard physical therapy exceeded our patient on only 1 of the 4 outcome measures – the TUG. However, with a post-treatment TUG time of 8.65 seconds, our patient came much closer to meeting the population mean for healthy cohorts of 8 seconds than did the group who received standard physical therapy (post-treatment TUG time of 9.7 seconds). Because our patient's pre-treatment TUG score was only 2.5 seconds slower than the population mean, there was a small window of improvement to be made before falling within 1 standard deviation of the population mean. While both our patient and the subjects who received standard physical therapy were within 1 standard deviation of the population mean for TUG scores, for the other two performance-based measures (knee flexion AROM and 6MW) this same accomplishment was only achieved by our patient.

Direct comparison of results from this case study to those reported in the case series of 5 subjects who received manual therapy and exercise following TKA is possible only for the TUG, as this was the only outcome measure utilized in both studies. The average post-treatment TUG score of the 5 subjects in the case series was 8.02 seconds compared to 8.65 seconds for our patient. As shown with our patient, the patients in the case series performed as well as or better than subjects in other studies investigating outcomes following TKA and in some cases when compared to healthy cohorts (Kramer, et al, 2003; Mizner, et al, 2005b; Moffet, et al, 2004; Steffen, et al, 2002).

This case study suggests that an impairment-based, hands-on treatment approach utilizing manual therapy techniques in addition to exercise and training in functional activities is an effective way to treat patients following TKA. The improvements in ambulation and knee flexion AROM exceeded those previously reported in the literature for outcomes following standard PT (Bade, et al, 2010; Kramer, et al, 2003; Moffet, et al, 2004). Improvements in AROM also exceeded those reported following more recent rehabilitative programs centered on progressive high intensity exercises (Mizner, et al, 2005b; Petterson, et al, 2009). Only

performance in ambulation activities fell below outcomes following intensive rehabilitation. However, it is important to consider whether an intensive rehabilitation program would be appropriate for all patients, particularly for those with cardiovascular disease or uncontrolled hypertension. Even knee pain, which has been reported to peak 1 month after surgery (Mizner, et al, 2005b), may inhibit a patient's ability or desire to perform intensive exercises. It is for these patients especially that a manual therapy approach may yield better outcomes due to its pain- and anxiety-relieving effects (Fernández-Pérez, Peralta-Ramírez, Pilat, & Villaverde, 2008; Hains, et al, 2010; Pedrelli, et al, 2009; Pollard, et al, 2008; Toro-Velasco, Arroyo-Morales, Fernández-de-Las-Peñas, Cleland, & Barrero-Hernández, 2009).

### **Limitations and Suggestions for Further Research**

Because the patient described in this case study was a participant in a larger study in which certain parameters were manipulated to improve generalizability of the results, many of the limitations inherent in a case study were avoided. Most notably, the patient was not chosen for inclusion in the case study because she achieved exceptional results on outcomes (as may be done in a retrospective case report) nor because of her potential to achieve exceptional results (as may be done in a prospective case study) but rather because she met pre-established inclusion and exclusion criteria meant to permit comparison of results to earlier studies investigating outcomes following TKA. In fact, the patient had a large number of co-morbidities and poor health habits (hypertension, diabetes, depression, arthritis, obesity, and tobacco-use) that may have negatively impacted her performance on outcome measures, as number of comorbid conditions has been shown to be a negative predictor of function following TKA (Jones, Voaklander, & Suarez-Alma, 2003).

This case study incurred all of the limitations inherent in the larger experimental study from which it was produced. Based on a one-group pretest-posttest design, the case study lacked both a control group and a sufficient number of administrations of each outcome measure throughout the course of treatment. Without a control group, one cannot ascertain whether improvements resulted from the study intervention, from extraneous factors (such as normal tissue healing), or from a combination of the two. And with all but one outcome measure being administered on just the first and last sessions, it is not known whether improvements were linear

or fluctuating and whether improvements reached an early plateau. Additionally, the absence of a follow-up prevented evaluation of the long-term effectiveness of the treatment.

Due to the prospective design of the case study, in which both the patient and the treating physical therapist were aware that outcomes would be utilized for research, it is possible the patient's performance on outcome measures (especially the subjective report of function) was influenced by her desire to fulfill the researchers' expectations. It is also possible that the physical therapist's belief regarding the effectiveness of the treatment may have influenced the quality of delivery of treatment, thus facilitating the patient's improvements.

It is recommended that future randomized controlled trials be conducted in which a control group receiving standard physical therapy is compared against a treatment group receiving both standard physical therapy and manual therapy. Both performance-based outcome measures and self-reported measures of function should be utilized; however, at a minimum, a mid-treatment assessment should be administered in addition to a follow-up assessment. Lastly, the subjects and the investigator who conducts the assessments should be blinded to group allocation.

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## Tables

**Table 1: Patient Outcomes**

Outcome measure	TKA at 3 weeks	TKA at 2 months
TUG	10.47 seconds	8.65 seconds
6MW	245.4 meters	454.2 meters
Knee flexion AROM	108 degrees	130 degrees
SF-36 PCS	21	34

**Table 2: Outcomes from standard PT following TKA (Bade, et al, 2010)**

Outcome measure	TKA at 1 month	TKA at 3 months
TUG	14.6 seconds (SD 12.3 seconds)	9.7 seconds (SD 2.7 seconds)
6MW	255.4 meters (SD 156.2 meters)	412.9 meters (SD 109.7 meters)
Knee flexion AROM	96.1 degrees (SD 13.0 degrees)	111.5 degrees (SD 10.2 degrees)

**Table 2b: Outcomes from Intensive PT following TKA (Moffet, et al, 2004)**

Outcome measure	TKA at 2 months	TKA at 4 months
SF-36 PCS	32.8 (SD 7.6)	38.8 (SD 9.9)

**Table 3: Normative data for community dwelling older adults**

TUG*	8 seconds (SD 2 seconds)
6MW*	538 meters (SD 92 meters)
Knee flexion AROM**	131.0 degrees (11.0 degrees)
SF-36 PCS***	44.34

\*Steffen, et al, 2002

\*\*Roach and Miles, 1991

\*\*\*Cleary and Howell, 2006