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The Use of Therapeutic Exercises and Manual Stretching for a Patient Following a Total Knee
Arthroplasty (TKA) Revision: A Case Report

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The patient signed an informed consent allowing the use of medical information and video footage for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act.

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ABSTRACT

Background and Purpose: Total knee arthroplasty (TKA) ranks among the most frequently performed orthopedic procedures in the United States. Approximately 581,000 people undergo TKA annually, and the number of procedures is expected to increase significantly by 2030. The purpose of this case report was to document the potential benefits of prescribed physical therapy (PT) interventions for a patient following TKA revision.

Case Description: The patient was a 69-year-old female post her eighth right (R) knee surgery, a TKA revision, due to an aseptic loosening of components from a previously placed artificial joint. The original TKA was eleven years prior. She received inpatient PT at a skilled nursing facility six times a week for just over two weeks. Her plan of care included manual stretching, strengthening, patient education, functional mobility training, and cryotherapy.

Outcomes: Improvements were noted in all measured outcomes at discharge. Pain intensity decreased on the Numeric Pain Rating Scale (8/10 to 5/10 at rest), active R knee range of motion improved (7-42 to 3-105 degrees), and R knee swelling decreased circumferentially (16.5 to 15 inches around the mid patella). A Timed Up and Go Test (TUG) was performed at three intervals during her stay to assess gait speed and quality, with improvements noted each time in speed (TUG attempts: 23, 19, and 14 seconds).

Discussion: This patient appears to have benefited from rehabilitation following TKA revision. Many studies support receiving skilled PT services following TKA opposed to routine care. Research suggests implementing quadriceps strengthening, manual stretching, and gait training as skilled PT interventions post TKA. Further research is needed to determine the potential long-term benefits of skilled PT services.

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BACKGROUND and PURPOSE

Total knee arthroplasty (TKA), also known as total knee replacement, is an orthopedic surgery involving specific compartments of the knee joint being replaced by artificial parts. According to the American Academy of Orthopedic Surgeons (AAOS), approximately 581,000 TKAs are performed each year.¹ By 2030, the demand for TKA is projected to grow by 673% to 3.48 million procedures annually.^{1,2} Osteoarthritis (OA) is the most common reason for TKA, and the risk factors that contribute to the disease are obesity, sports-related injuries, and genetics.¹

Most studies confirm that 80-90% of total knee replacements, or prostheses, will last between 15 and 20 years; however, early failures may occur due to a number of factors including loosening of the artificial components, infection, fractures, and instability.¹ In cases of prosthetic failure, the surgeon may elect for a TKA revision.¹ The rate of prosthesis failure which will require a revision increases from 10 percent at 10 years, to 20 percent at 20 years, post-surgery.³ The durability of the prosthesis depends upon multiple factors, including patient age, underlying disease, obesity, and the quality of the arthroplasty and the artificial pieces.²

Skilled physical therapy (PT) services are recommended following TKA. A 2007 meta-analysis of five randomized control trials determined that participation in PT following surgery can help improve knee function and range of motion (ROM) in the short-term when compared to routine care.⁴ Evidence shows that a well-structured PT plan of care (POC) should include ROM, gait training, quadriceps strengthening, and training in activities of daily living (ADL).⁴ Research suggested that the goals for rehabilitation should be the same for both TKA and TKA revision.⁴ There is limited data reporting on the long-term outcomes of rehabilitation following TKA.

A study by Alaca et al.⁵ looked at the differences between two comparison groups, proprioceptive neuromuscular facilitation (PNF) therapy and continuous passive motion (CPM) therapy, in 30 patients following TKA. Results showed that the PNF group had more significant ROM improvements and demonstrated earlier functional gains when compared to the CPM group.⁵ This study suggested that the use of PNF techniques may be a beneficial strategy for regaining knee ROM following TKA. Research is limited on the long term benefits of PNF following TKA.

The purpose of this case report was to document the potential benefits of specific PT interventions, including therapeutic exercise and manual stretching, for a patient who underwent TKA revision. The author and clinical instructor used evidence based practice as well as clinical experience to conduct the plan of care for the patient. This case report is needed due to the growing number of patients undergoing TKA surgeries and revisions, as evidenced by the increased frequency of the procedures.

CASE DESCRIPTION

Patient History and Systems Review

The patient signed an informed consent allowing the use of her medical information for this case report. She was a 69-year-old female, status post right (R) TKA revision, referred for PT at a skilled nursing facility (SNF) by her orthopedic surgeon. Two weeks prior to her initial evaluation (IE) with PT, she had complained of increased R knee pain. She had been very active prior to this admission, noting that she walked about 10 miles per day. She had a past medical history of several R knee arthroplasty procedures, with the latest revision being her eighth knee surgery since the original TKA eleven years previously. Prior to her latest procedure, she lived alone in a single family home and was fully independent with all ADL's. She was able to drive and ambulate in the community without an assistive device, and her two children lived in the area to assist as needed. She reported to her primary care physician where subsequent X-ray imaging revealed an aseptic loosening of components in her R knee from previous surgeries. A right TKA revision was performed, and after a four day hospital stay the patient was admitted to a SNF for PT. Comorbidities included recurrent urinary tract infections (UTI), urinary incontinence, hypertension, gout, and fibromyalgia. At the time of her IE, her chief complaints included pain, swelling, and decreased ROM at the R knee. Her main goals were to regain prior level of function (PLF) and to be able to live safely and independently at home again with her dog. Results of the systems review can be found in Table 1.

Clinical Impression 1

During her IE, all impairments were consistent with R TKA revision and her past medical

history. Prior to therapy, the patient's condition was assessed by an orthopedic surgeon and the subsequent impairments were consistent with the surgical procedure. Therefore, there were no potential differential diagnoses. Following the subjective history and systems review, it was hypothesized that the patient presented with impaired R lower extremity (RLE) strength, increased swelling, decreased knee ROM, and decreased gait speed. The Numeric Pain Rating Scale (NPRS) was used to determine the level of pain at rest and pain with movement. Goniometric measurements were used to document ROM of the surgical and non-surgical knees. Manual muscle testing (MMT) was not performed on the RLE due to post-surgical precautions, but MMT on the left LE was completed to get a baseline measure of strength. No special tests were performed due to post-surgical precautions.

At IE, the patient had physician orders to be in an Information, Risk, and Operations Management (IROM) brace (DonJoy, Holt, Michigan) locked in R terminal knee extension during all weight bearing (WB) activities. Gait pattern was antalgic and she demonstrated slow walking speed, decreased stance time on the RLE, and decreased step length bilaterally. See Appendix 2 for further details on gait analysis. Impairments in gait may have been attributed to the limitations in R knee flexion by the IROM brace, along with decreased RLE strength and ROM.⁶ The Timed Up and Go (TUG) test was performed during the IE, and the patient scored 23 seconds with use of a front wheeled walker (Medical Depot, Inc., DeVilbiss Healthcare, Port Washington, NY) which classified her as a fall risk.⁷

This patient was a good candidate for a case report because she was motivated to improve and had a high PLF. Based on the high prevalence of this procedure in the US, it is critical for therapists to have knowledge of the different approaches, complications, and expected outcomes of the rehabilitation for patients who have undergone TKA.

Examination – Tests and Measures

Results of the tests and measures performed during the IE can be found in Table 2. ROM was assessed in supine using an EZ Read Jamar Goniometer (Patterson Medical, Danbury, CT). Goniometric measurements were performed as described by Norkin and White.⁸ MMT was not performed on the RLE due to post-surgical precautions. Muscle activation was determined by

observing a single ten second quadriceps set on the RLE. The patient was able to elicit a fairly strong visible and palpable contraction. Observation of the integumentary system is described in Table 1. An image of the surgical incision four days after surgery can be found in Figure 1.

Gait was originally observed when the patient walked from her room at the facility to the gym. An antalgic gait pattern was noted with decreased stride length bilaterally and decreased cadence. The patient also demonstrated decreased stance time on the RLE.⁶ A Timed Up and Go (TUG) Test was performed to assess mobility, balance, walking ability, and potential fall risk.⁷ The TUG was completed by following the protocol set by the Centers for Disease Control,⁹ which can be found in Appendix 1. The evidence is limited on the reliability and validity of a TUG at predicting future ambulation for people who have undergone TKA. It is important to note that this test should not be used in isolation when predicting falls in community dwelling adults, as reported by Barry et al.¹⁰ However, this test was useful in allowing the therapist to determine improvements in both gait speed and quality.⁷

Clinical Impression 2

Based on the examination data, the clinical impression was confirmed and the results were consistent with a post-surgical R TKA revision. The patient continued to be appropriate for this case because she had remaining functional deficits that had prevented her from returning to her prior living residence and the community. Those functional deficits were addressed with skilled PT interventions. See Table 6 for a detailed look at progression of functional mobility.

The ICD-10 medical diagnosis for this patient was Z96.651, presence of right artificial knee joint. The ICD-10 PT diagnosis was R26.2, difficulty in walking. Research suggested that PLF and baseline LE strength were two important prognostic factors.¹¹ A study by Jones et al. looked at the determinants of function following TKA using the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index.¹¹ The results showed patients with a lower preoperative status performed at a lower level at six months than patients with a higher preoperative functional status. The results were insignificant when comparing age and gender. This patient had an excellent prognosis for therapy given her high PLF, overall health, compliance with treatment, and participation in therapy. Jones et al¹¹ did not factor previous number of knee procedures into their determinants of function

following TKA. This may have been a negative prognostic indicator for this patient, with this revision being her eighth procedure on the same LE.

Coordination with the surgeon was important for evaluating the progress of therapy and for determining an appropriate discharge date. There was no medical need for additional referrals or other consultations. The plan for additional testing included MMT of the RLE, stair climbing, and car transfers (once post-surgical precautions were lifted). Pain, ROM, gait quality, and TUG scores were to be re-assessed prior to discharge. The main focus of the POC was to regain R knee ROM and to strengthen the RLE. Plans for interventions included manual stretching, LE strengthening in different positions, gait training, and patient education. At the end of every treatment session, the therapist would secure an Aircast Cryo/Cuff (DJO LLC, Vista, CA) around the R knee with a gravity cooler attached for cryotherapy. The patient was positioned in supine with the RLE elevated on a pillow for 20 minutes. The short and long-term goals set by the PT can be found in Table 3.

INTERVENTIONS

Coordination, Communication, and Documentation

A POC was established for this patient following the IE. After her first week of therapy, she attended an appointment with her orthopedic surgeon. The patient received both physical and occupational therapy six times a week for two weeks. Therefore, it was important that all therapists maintained communication regarding remaining functional limitations in order to facilitate discharge planning and decision making. For documentation, hand written flow sheets were recorded daily to track progression/regression. A progress note was completed ten days following IE via electronic medical records (EMR) for insurance purposes. At the end of her two week length of stay, a discharge note was completed using the same EMR system.

Patient/Client Related Instructions

During the IE, the patient was educated on her PT POC, the importance of achieving functional R knee ROM, proper use of the Cryo/Cuff machine and FWW, and discharge plans (see Table 4 for details). Upon discharge, she was educated on compliance with her home exercise program (HEP) and to follow up with her surgeon about receiving outpatient PT services.

Procedural Interventions

The patient was compliant with her PT POC and attended all scheduled appointments. Interventions were performed over 15 treatment days, all of which were completed at the same SNF. The patient attended therapy six times a week, and each session was an hour in length. The focus of procedural interventions was on regaining R knee ROM and strengthening the RLE, emphasizing the R quadriceps (quad) muscle. Research suggested that persistent quad weakness following TKA may result in decreased functional mobility, which can prolong the patient's return to ADL.¹² Procedural interventions were broken up into two phases: Phase 1 (days 1-7) and Phase 2 (days 8-15). The parameters used for interventions during each Phase can be found in Table 5.

Heavy emphasis was placed on supine therapeutic exercises (ther-ex) during Phase 1 due to post-surgical orders of non-weight bearing without the brace. Quad sets were stressed in order to improve neuromuscular activation to help achieve terminal knee extension (TKE), which research suggested is more difficult to regain than knee flexion.¹² On treatment day one, the patient was able to elicit an active and visible quadriceps contraction. A towel was placed under the patient's R knee and she was instructed to press into it while simultaneously dorsiflexing her R ankle. This exercise was progressed by having her hold the contraction longer for an increased number of repetitions. The therapist progressed the exercise once the visible and palpable quad contraction became stronger. Other supine ther-ex performed during Phase 1 included short arc quads (SAQ), straight leg raises (SLR), and heel slides. Images and descriptions for these exercises can be found in Figures 2 and 3.

AAROM exercises were performed to address limited R knee ROM. One intervention was performed with the patient seated in a wheelchair facing a staircase in order to allow for R knee flexion in a different position. The patient pressed the front of their R shoe into the bottom step while moving the wheels of the chair forward. The therapist gave cues for her to allow her knee to bend into flexion as much as tolerated. The patient was told to relax the muscles around the knee and to exhale during end range overpressure. This was progressed by increasing repetitions once R knee flexion started to improve.

On day 11, the surgeon updated the patient's status to weight bearing as tolerated (WBAT) without the brace, which allowed the therapist to further progress her interventions. Supine ther-ex was progressed by adding load and repetitions based on clinical knowledge of how to maximize strength gains at target muscle groups. Supervision and verbal cues were provided to correct form and to ensure proper muscle activation. The therapist had the patient complete exercise on the NuStep machine (NuStep Inc., Ann Arbor, MI), a recumbent upper and lower body cross trainer, in order to increase cardiovascular endurance, allow AAROM at the R knee, and improve WB tolerance. The resistance was progressed on the NuStep once the patient was able to complete 15 minutes of pain free exercise with a low load (Level 1).

Standing ther-ex was added into the POC once full WB was allowed. Research suggested that combining open and closed kinetic chain exercises early in post-operative rehabilitation was an integral part of gaining optimal strength.¹³ Closed chain exercises have been found to be more functional and can combine multiple muscle groups when utilized with proper form.¹³ Sit to stand exercises were completed from sitting on the high-low table. Initially, the patient stood from a higher table position, with her hips higher than knee level, until she could safely demonstrate ten sit to stand repetitions without UE assistance. At that time the table height was lowered, so the hips and knees were at the same level, in order to further challenge her quads and glutes and to promote functional strength gains.

An additional focus was made to strengthen the hip abductors during Phase 2. Some research suggested that targeting these muscles following TKA is crucial for improving functional mobility.¹⁴ A cross-sectional study by Sara et al.¹⁴ found that the force generating capacity of one's abductors following TKA may contribute more to physical function than that of the quadriceps. Descriptions of the abductor strengthening exercises performed by this patient can be found in Figure 3 (clam-shells) and Figure 4 (standing abduction).

Emphasis was placed on manual stretching in order to help achieve ROM goals during Phase 2. PROM stretching was performed into flexion and extension with slight end range over pressure as tolerated. Research is limited on the effectiveness of manual stretching following TKA; however, the treating clinician's experience had demonstrated beneficial results with this intervention previously.

The therapist also PNF techniques with the patient in sitting. The patient had their RLE off the mat while the therapist passively flexed the R knee until a point of discomfort was reached. At that time the patient was instructed to try to extend their R knee against the resistance of the therapist's hand. This isometric position was held for 5 seconds, and then she relaxed as the therapist passively advanced her R knee into a more flexed position. The contract-relax PNF technique was performed for four to five repetitions. Goniometric measurements were taken every three treatment sessions in order to document improvements. A more detailed look at the procedural interventions performed during Phase 2 can be found in Table 5. Gait training was performed at every treatment session, and the analysis and progression can be found in Appendix 2.

OUTCOMES

Tests and measures from the IE were performed at discharge by the same therapist, in order to obtain the most reliable intra-rater results (see Table 2 for comparison). Upon discharge, the patient was independent with all functional mobility tasks with the use of a FWW (see Table 6 for mobility progression). Improvements in R knee ROM allowed for increased independence with ADL's, as well as improved gait speed and quality. Refer to Appendix 2 for an analysis of gait progression. During the IE, stair climbing was not tested secondary to post-surgical precautions. At discharge, the patient climbed eight stairs with use of both handrails safely with a step-to pattern. She demonstrated good understanding of fall prevention techniques and was able to safely and independently use the FWW for all forms of mobility. The patient was able to safely perform therapeutic exercise in sitting, supine, and standing with proper form. She was agreeable to continue with her HEP and to follow up with outpatient PT services in the community in order to address remaining impairments. She noted that her two children lived nearby and were able to help her as needed.

DISCUSSION

This case report described the post-surgical rehabilitation for a patient who underwent TKA revision following 15 days of prescribed PT interventions. The patient was provided a POC based on research evidence and clinical judgment. The intended purpose of this case report, to document the potential benefits of combining manual stretching techniques and therapeutic exercise for a patient

following TKA revision, was achieved. The patient made good progress during 15 days of inpatient rehabilitation with improvements in functional mobility tasks, gait speed and quality, R knee ROM, strength, and pain level. These results suggested that manual stretching and therapeutic exercise may have been beneficial interventions for improving functional mobility. Factors that may have positively attributed to her recovery included high PLF, overall good general health, her compliance and participation in PT, and the interventions provided. Potential negative factors included pain limitations, history of multiple R knee procedures, and comorbidities.

The reported outcomes were consistent with current research that participation in therapy, including quadriceps strengthening, gait training, and stretching, can help improve knee function and ROM following TKA. Further research is warranted to explore the potential long-term benefits of PT interventions with TKA. With the increasing number of TKA procedures projected, it is necessary for more research to be conducted on optimal interventions in order to maximize knee function and performance. Continued research on the rehabilitation process following TKA can have major implications on future clinical practice in many settings including acute care, SNF, home health, and outpatient. Specifics regarding types of interventions and parameters should be tested and evaluated in order to provide the most beneficial POC.

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TABLES and FIGURES

Table 1: Systems Review

Cardiovascular/Pulm	Not impaired
Musculoskeletal	R LE: AROM: impaired/limited flexion & extension Gross strength: impaired Gait is impaired with antalgic pattern and decreased R knee flexion due to IROM brace for weight bearing precautions per surgeon. L LE: not impaired
Neuromuscular	Mild numbness noted slightly inferior and lateral to patella
Integumentary	Incision down the midline of the leg from the distal femur to the proximal tibia 8.5 inches long. 21 stitches used. Residual ecchymosis and swelling noted surrounding right knee, with some pooling down the distal tibia. A/P circumference R knee: 16.5” A/P circumference L knee: 14”
Communication	Not impaired
Affect, Cognition, Language, Learning Style	Not impaired Leaning style: verbal, demonstrations

Lower extremity (LE), active range of motion (AROM), right (R), left (L), information, risk, and operations management (IROM), A/P (anterior/posterior)

Table 2: Tests and Measures

Tests & Measures	Initial Evaluation Results	Discharge Results
Manual Muscle Test	R LE: did not test L LE: 5/5	R LE: 4/5 L LE: 5/5
Goniometry (extension-flexion): AROM	R knee: 7-42 degrees L knee: 0-125 degrees	R knee: 3-105 degrees L knee: 0-125 degrees
Numeric Pain Rating Scale (0-10)	Best: 7 Worst: 10 Current: 8 Description: sore and achy	Best: 4 Worst: 7 Current: 5 Description: sore and achy
TUG (comfortable speed)	23 seconds	14 seconds

Right (R), left (L), Lower extremity (LE), Timed Up and Go (TUG), passive range of motion (PROM)

Table 3: Short and Long-term Goals

Short-term Goals: Two Weeks	Long-term Goals: Four Weeks
Patient will safely perform functional transfers with Modified Independence with reduced risk for falls, as measured by no falls or LOB, in order to return to prior level of functional abilities.	Patient will safely perform functional transfers with Independence with reduced risk of falls, as measured by no falls or LOB, in order to safely return to private residence.
Patient will safely ambulate on level surfaces 250 feet using Front Wheeled Walker with Modified Independence with even step length, continuous steps, and with normal cadence 90% of the time w/o LOB to return to prior living and supervision levels.	Patient will safely ambulate on level and uneven surfaces unlimited distances using no assistive device with Independence with even step length, continuous steps, and with normal cadence 100% of the time w/o LOB to return to prior living and supervision levels.
Patient will safely ascend/descend 2 stairs (up with L LE, down with R LE) with CGA using handrails bilaterally and occasional verbal cues for safety awareness, for use of hand rails, and for proper sequencing with reduced risk for falls.	Patient will safely ascend/descend 12 stairs (up with L LE, down with R LE) with Independence using handrail on the left and 0% verbal cues with reduced risk for falls.
Patient will achieve 4-85 degrees of R knee AROM to increase independence with functional mobility tasks.	Patient will achieve 0-110 degrees R knee AROM in order to achieve functional independence with mobility tasks.

LOB (loss of balance), CGA (contact guard assist), R (right), L (left), LE (lower extremity)

Table 4: Patient-related Instruction/Education at Initial Examination

WB status	During the initial evaluation, the therapist educated the patient that she must wear her IROM brace for all WB activities. At initial evaluation, the patient was WBAT with the brace on.
IROM brace	The therapist educated the patient on proper donning and doffing of the IROM brace.
Assistive device	The patient was educated on proper use of the FWW, including keeping it close, for all functional mobility activities.
R knee ROM	The patient and therapist discussed the importance of achieving R knee flexion and extension in order to return to ADL's.
Cryotherapy	The patient was educated on proper use of the Cryo/Cuff machine, as well as the recommended duration of application in order to reduce swelling and pain.
PT POC	During the initial evaluation, the patient was educated on the role of PT, the PT POC, her impairments, goals, and discharge planning.

Weight bearing (WB), Information, Risk, and Operations Management (IROM), plan of care (POC), activities of daily living (ADL), front wheeled walked (FWW)

Table 5: Post-op PT Interventions

Interventions	Initial Evaluation	Phase 1 (days 2-7)	Phase 2 (days 8-15)
Quad sets (supine)	5" hold x 20 reps	10" hold x 40 reps	Discontinued day 11
Straight leg raises (supine)	R LE: 3 sets x 15 reps with 0 lb weight L LE: 3 sets x 15 reps with 2.5 lb weight	R LE: 3 sets x 20 reps with 1.5 lb weight L LE: 3 sets x 20 reps with 3 lb weight	R LE: 3 sets x 20 reps with 2.5 lb weight L LE: 3 sets x 20 reps with 4 lb weight
Clamshells (side-lie)	3 sets x 15 reps with red TB	3 sets x 20 reps with green TB	Discontinued day 10
Short arc quads (supine)	R LE: 3 sets x 15 reps with 1.5 lb weight L LE: 3 sets x 15 reps with 2.5 lb weight	R LE: 3 x 20 reps with 2.5 lb weight L LE: 3 x 20 reps with 4 lb weight	R LE: 3 x 20 reps with 3 lb weight L LE: 3 x 20 reps with 4 lb weight
Hamstring curls (seated)	3 sets x 15 reps with red TB	3 reps x 20 reps with green TB	3 reps x 20 reps with blue TB
Long arc quads (seated)	R LE: 3 sets x 15 reps with 1.5 lb weight L LE: 3 sets x 15 reps with 3 lb weight	R LE: 3 sets x 20 reps with 2.5 lb weight R LE: 3 sets x 15 reps with 4 lb weight	Discontinued day 10
AAROM at steps for knee flexion (seated)		5" hold x 20 reps	5" hold x 40 reps
Heel slides with towel (supine)		3 sets x 15 reps	3 sets x 20 reps
Manual stretching of R knee flexion/extension with overpressure (supine)		30" hold x 3 for both flexion and extension	30" hold x 3 for both flexion and extension. Added PNF component with contract-relax on day 8.
Cryo/Cuff (supine, R LE elevated)	R knee x 20 minutes	R knee x 20 minutes	R knee x 20 minutes
Bridges (supine)			3 sets x 15 reps
NuStep machine (seated)			Level 1-4 x 20 minutes
Standing TKE			3 sets x 20 with green TB
Standing hip abduction			R LE: 3 sets x 20 reps with 2.5 lb weight L LE: 3 sets x 20 reps with 3 lb weight
Sit to stands (seated on high-low mat)			1-3 sets x 10 reps, progressively decreasing mat height each day

Reps (repetitions), R (right), L (left), LE (lower extremity), lb (pound), AAROM (active assisted range of motion), TKE (terminal knee extension), PNF (proprioceptive neuromuscular facilitation), x (times)

Table 6: Functional Mobility Outcome Progression during SNF Stay

Functional Outcomes	Initial Eval (4 days Post-op)	PT Day 7 (11 days Post-op)	Discharge (19 days Post-op)
Bed mobility	Independent	Independent	Independent
Transfers (sit-to-stand and stand-to-sit)	Supervision (with FWW)	Modified independence (with FWW)	Modified independence (with FWW)
Car transfer	Not tested	Supervision (with FWW)	Modified independence (with FWW)
Stairs	Not tested	4 steps, both HR, step-to-pattern	8 steps, both HR, step-to-pattern
TUG	23 seconds (with FWW)	19 seconds (with FWW)	14 seconds (with FWW)

Hand rail (HR), front wheeled walker (FWW), Timed up and go (TUG)

Figure 1: Surgical Incision at Initial Evaluation (Four Days Post-Op)



Figure 1: Incision down the midline of the anterior, right lower extremity from the distal femur to the proximal tibia 8.5 inches long with 21 stitches used. Residual ecchymosis and swelling noted surrounding right knee, with some pooling distally along the tibia.

Figure 2: Supine Ther-ex

A.



B.



Figure 2: A demonstrates supine heel slides with a gait belt for active-assisted range of motion (AAROM) of the R knee. The patient looped the gait belt around her foot and pulled on it in order to flex the knee as much as tolerated. B shows a short-arc quad exercise. A round, 8 inch diameter bolster was placed under her knees. The patient tightened up her quad and straighten out her lower leg. Ankle weights were added to increase difficulty with the goal to strengthen the quads. This exercise was performed bilaterally; this image shows a SAQ at the L knee.

Figure 3: Supine and Side-lying Ther-ex

A.



B.

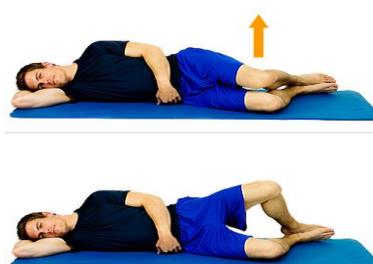


Figure 3: A. shows a straight leg raise in the supine position. The patient was asked to tighten up their quad and lift their leg off the mat to the height of the opposite, bent knee. Ankle weights were added to increase difficulty. The targeted muscles were the quads and hip flexors. B. demonstrates a clam shell in side-lying. The patient was positioned in side-lying and asked to open up the top hip without allowing their pelvis to roll backwards. This targeted the hip abductors. Resistance bands were later tied around the knees to increase difficulty (images from physicaltherapyfirst.com).

Figure 4: Standing Ther-ex

A.



B.



Figure 4: A and B demonstrate open chain standing therapeutic exercises. A. is targeting the glute max. The patient was instructed to bring her leg straight back while holding on to the railings for balance. B. is targeting the abductors. The patient was instructed to lift her leg straight out to the side while holding on to the railings. Ankle weights were also added to increase the difficulty of these exercises.

Appendix 1: Protocol for the Timed Up and Go Test (TUG)⁷

Purpose: To assess mobility

Equipment: A stopwatch

Directions: Patients wear their regular footwear and can use a walking aid if needed. Begin by having the patient sit back in a standard arm chair and identify a line 3 meters or 10 feet away on the floor.

Instructions to the patient:

When I say “Go,” I want you to:

1. Stand up from the chair
2. Walk to the line on the floor at your normal pace
3. Turn
4. Walk back to the chair at your normal pace
5. Sit down again

On the word “Go” begin timing.

Stop timing after patient has sat back down and record.

Time: _____ seconds

An older adult who takes ≥ 12 seconds to complete the TUG is at high risk for falling.

Observe the patient’s postural stability, gait, stride length, and sway.

Appendix 2: Gait Analysis

Day(s)	Distance	Assistive Device/ PT Supervision	WB Status	Gait Quality	Surface
1	75 ft	FWW with Sup.	WB w/ IROM brace	Decreased cadence and stride length (feet did not pass each other B/L), decreased R knee flexion, antalgic gait (decreased stance time on R LE), step to pattern	Level
2-6	150 ft	FWW with Sup.	WB w/ IROM brace	Decreased cadence and stride length (feet did not pass each other B/L), decreased R knee flexion, antalgic gait (decreased stance time on R LE), step to pattern	Level
7	275 ft	FWW with mod. I.	WB w/ IROM brace	Improved stride length, continuous steps, slight decrease in antalgic gait	Level
8	100 ft	FWW with mod. I.	WB w/ IROM brace	Improved heel strike and PF propulsion	Uneven (outdoor patio)
10-15	350 ft	FWW with mod. I.	WBAT (no brace)	Improved cadence and stride length, increased R knee flexion	Level
15	350 ft	FWW with mod. I.	WBAT (no brace)	Normalized gait pattern with slight remaining antalgic gait	Uneven (outdoor patio)

Front-wheeled walker (FWW), supervision (Sup.), modified independence (mod. I.), feet (ft), weight-bearing (WB), weight-bearing as tolerated (WBAT), information, risk, and operations management (IROM), plantar-flexion (PF), right (R), lower extremity (LE), bilaterally (B/L)