Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 5 Issue 1 January 2022

Case Report

Physical Therapy Interventions and Outcomes in a Patient with Transfemoral Amputation Following Sound Side Total Knee Arthroplasty: A Case Report

Scott Love[1]*, Jenna Yent[1], Clair V Kean[1], Nicole A Liotta[1], Debra Gray[1] and M Jason Highsmith[2-4]

[1]University of St. Augustine, Doctor of Physical Therapy Program, St. Augustine, FL, USA

[2]University of South Florida, Morsani College of Medicine, School of Physical Therapy and Rehabilitation Sciences, Tampa, FL, USA

[3]U.S. Department of Veterans Affairs, Rehabilitation and Prosthetic Services (10P4R), Orthotic and Prosthetic Clinical Services, Tampa, FL, USA

[4]U.S. Army Reserves, 319th Minimal Care Detachment, SP Corps, Pinellas Park, FL, USA

***Corresponding Author:** Scott Love, Assistant Professor, University of St. Augustine, Doctor of Physical Therapy Program, St. Augustine, FL, USA.

Received: October 08, 2021

Published: December 14, 2021

© All rights are reserved by **Scott Love.*, et al.***

Abstract

Background: Following a transfemoral amputation (TFA), osteoarthritis (OA) on the sound limb may occur secondary to overuse. Potential causative factors include gait abnormalities, increased knee load, and performing hopping activities without a prosthesis. Unilateral TFA patients may require a total knee arthroplasty (TKA) to improve function.

Case Description and Methods: A 56-year-old male with a TFA who was diagnosed with left knee OA and was classified as a limited community ambulator underwent a TKA to restore function. The purpose of this case report is to determine the benefits of standard physical therapy (PT) augmented by a high intensity, whole-body strengthening program. PT examinations, interventions, and outcomes were analyzed from one-week pre-TKA to one-year post-TKA. Multiple outcome measures were utilized to assess progress including the Single Leg Stance Test (SLST), Four Square Step Test (FSST), Timed Up and Go Test (TUG), and Six Minute Walk Test (6MWT).

Findings: Patient achieved functional independence, normalized gait, lower extremity strength, and lower extremity active range of motion (AROM) goals.

Outcomes and Conclusion: The results of the TUG and FSST from the patient equaled those of non-amputees. The standard PT protocols post-TKA contributed to the patient's success, while the high intensity, whole-body strengthening program contributed to patient's achievements.

Clinical Relevance Statement: This case study suggests rehabilitation interventions in a relatively healthy unilateral TFA with sound limb TKA may be appropriate at a higher level of intensity, than typically prescribed, to regain functional independence.

Keywords: Lower Extremity Amputee; Prosthesis; Range of Motion; Rehabilitation; Timed Up and Go; Total Knee Replacement; 6MWT

Introduction

In the United States, there are approximately 185,000 lower extremity amputations (LEA) performed each year with the healthcare costs associated with these amputations calculated to be over $8.3 billion in 2009. Amputations may be performed on patients due to complications with diabetes, vascular disease, cancer, or infections, and may also occur for congenital or traumatic reasons [1]. Patients with LEA frequently experience secondary impairments of osteoarthritis (OA) in the sound limb, which can result in pain and decreased function. OA is a chronic and degenerative synovial joint condition, primarily affecting articular cartilage. In patients with unilateral LEA, it is important to recognize OA early on and assess if function could improve with surgical intervention as late-stage OA presentation commonly includes persistent pain which can lead to immobilization of the affected joint [1].

Abnormal gait patterns and joint mechanics as well as lack of prosthetic confidence, increase the risk for sound limb knee OA in patients with LEA [1]. Dynamic analysis of the gait pattern of patients with transfemoral amputation (TFA) demonstrated decreased gait speed, cadence, and stride length, and increased duration of sound limb stance phase [4]. New prosthetic technology has been developed to address unequal weight bearing through extremities in LEA to help prevent gait abnormalities which ultimately reduces the risk of developing knee OA in the sound limb [1]. However, it is important to note that not all TFA patients have access to advanced prosthetic technology. Additionally, rehabilitation access is often disparate, and courses of prosthetic care, rehabilitation, and outcomes are therefore highly variable [1].

This case presents functional improvements in a TFA patient with a sound limb TKA following standard physical therapy (PT) interventions supplemented by high intensity, whole body strength training.

Methods

Informed consent

Patient consent was obtained verbally for treatment and for personal and medical information to be utilized within retrospective study submitted to publication services.

Patient history

The patient was a 56-year-old male with history of competitive power lifting and CrossFit® participation. He contracted necrotizing fasciitis in the right knee while treating an infected patient as a physical therapist. He underwent 15 limb salvage surgeries over 3 years; however, the infection returned, necessitating a TFA 5.08cm above the right knee joint. This ultimately caused an alteration in his gait pattern, contributing to development of left knee OA. Magnetic Resonance Imaging (MRI) and radiographs confirmed the diagnosis of advanced OA in the left knee joint (Figure 1A and 1B) and the patient was referred to PT. Pre-surgical PT interventions focused on symptom management and improving sound limb strength and range of motion; however, a TKA was agreed upon by physical therapist, patient, and orthopedic surgeon after approximately three years of unsuccessful conservative management.

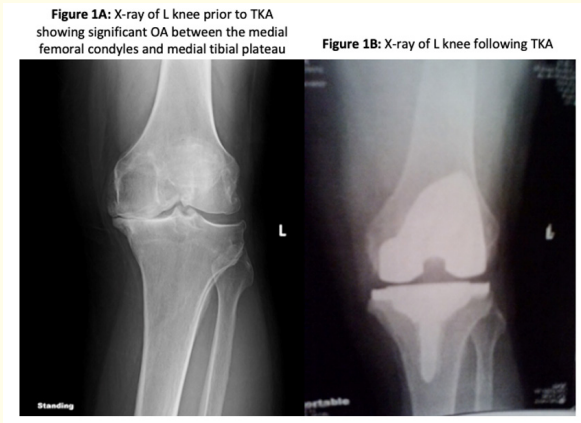

Figure 1

Range of motion and muscle testing

Left knee active range of motion (AROM) and passive range of motion (PROM) were measured using a long arm goniometer for flexion and extension, following the Norkin and White method [5]. Manual muscle testing was performed by one physical therapist to determine strength using the Kendall method [6].

Performance based outcome measures

Throughout the patient's rehabilitation, multiple outcome measures were utilized. The Single Leg Stance Test (SLST) was used to measure the patient's ability to stand on one leg unsupported without loss of balance. Those unable to perform the task for at least 5s are at increased risk for falls. The average value for this patient's age range (50 - 59y) in non-amputee males is 38.1s with eyes open

[7]. The Timed Up and Go (TUG) test was used to assess the patient's fall risk by using dual task dynamic activity. A time greater than 19s for LEA indicates an increased risk for falls [7]. Dynamic balance was further measured by assessing the patient's ability to step over a one-inch object in different directions using the Four-Square Step Test (FSST). A time of greater than 7.49s indicates an increased risk for falls for healthy adults aged 50 to 65 [8]. Lastly, the 6 Minute Walk Test (6MWT) was used to assess sub-maximal aerobic capacity and endurance by measuring distance walked in 6 minutes. The average distance for a TFA measured to be 343m ± 82 [9]. All four outcome measures are proven to be reliable and valid [7,8].

Goals

Patient goals included decreasing left knee pain and swelling, improving lower extremity muscle strength and AROM, improving independence with activities of daily living (ADL), normalizing gait, regaining the ability to run 1.56 m/s (1.61km) on the treadmill for 20 minutes with minimal upper extremity support, maneuvering a single flight of stairs with single hand held assist, ambulating 30.48m on uneven surfaces while carrying 11.34 kg, and completing a 5k with walking sticks in under 60 minutes.

Intervention

The patient attended PT two times per week for 33 weeks to improve function. The plan of care began with education which included a home exercise program (HEP), explanation of exercises, and timeline of pre and post-operative interventions. Patient PT included stretching, strengthening, joint mobilization, and gait training interventions [1]. Electrotherapeutic modalities were also utilized to reduce pain and swelling [10].

Weeks 1 - 8 PT interventions focused on standard post-TKA treatment. This included soft tissue massage, scar tissue mobilization and instrument assisted soft tissue mobilization (IASTM®). Passive manual and active assisted stretching were implemented to improve patient left knee A/PROM. To improve strength, left lower extremity therapeutic exercises were implemented [11]. Pain, edema and effusion management included cryotherapy and interferential electric stimulation.

Weeks 9 - 17 PT interventions focused on core and advanced lower extremity strengthening. This included therapeutic exercises such as planks, shuttle walks with elastic band resistance, bridges, step ups, static standing on a half Bosu® ball, and side stepping in both directions with and without a handrail. Gait and balance impairments were addressed using single leg stance, tandem stance, dynamic tandem walking, walking on a treadmill with upper extremity support, step overs, and walking on uneven surfaces.

Weeks 18 - 33 PT interventions included outdoor obstacle course activities. These sessions included commando crawling a distance of 9.14m, flipping industrial tires and telephone poles for 30.48m each, walking on a 4.57m slack line with arm support, scaling a 2.44m wall, navigating a 4.57m balance beam with no upper extremity assistance, dragging a 22.68 kg cement ball in increments of 60.96m. Sessions began with one repetition of each activity and progressed to five repetitions. Standard PT interventions were continued as needed to address acute pain and edema in the left knee. After week 33 the patient began independent obstacle course training for 20 weeks with a physical therapist colleague. This occurred two times per week, with five components of the obstacle course performed per session.

Results

Examination and systems review

At initial evaluation pre-TKA, the patient complained of pain and decreased performance of ADLs. Using a numerical pain scale, the patient reported 7/10 left knee pain at rest with 10/10 left knee pain with increased physical activity. The patient ambulated without an assistive device and with a right lower extremity prosthesis, a Genium microprocessor knee (Ottobock. Duderstadt, Germany). The patient was initially classified as a limited community ambulator with potential for increased gait function. He demonstrated antalgic gait and hip hiking to clear the prosthesis in swing phase. One-year post-TKA, the patient progressed to unlimited community ambulation with normalized gait and lacked notable deviations. Impairments resulted from right TFA and left TKA. Post TKA surgery, the patient attended 33 weeks of supervised PT.

Range of motion and muscle testing

Recorded in table 1, pre-TKA measurements of left knee A/PROM showed limited flexion (105°/111°) and extension (-19°/-15°). Post-TKA measurements one month post-op revealed improvements in A/PROM of left knee flexion (114°/115°) and extension (-3°/0°). A/PROM of left knee flexion and extension continued

to improve at plateaued at 123°/129° and 1°/2°. When assessing lower extremity muscle strength pre-TKA, manual muscle testing recorded the left gastrocnemius and anterior tibialis at 5/5 strength, however, strength deficits were noted in the left posterior tibialis, peroneals, gluteus maximus, medius, and minimus, hamstrings, and quadriceps. Post-TKA scoring revealed maintenance of left gastrocnemius and anterior tibialis at 5/5 strength and improvements in left posterior tibialis, peroneals, gluteus maximus, medius, and minimus, hamstrings, and quadriceps strength.

Follow up Period	Knee A/PROM		Manual Muscle Test										
	Flexion	Extension	Posterior Tibialis	Anterior Tibialis	Peroneals	Gastrocnemius	Soleus	Gluteus Medius	Gluteus Minimus	Gluteus Maximus	Psoas	Ham strings	Quadriceps
1 wk Pre-op	105°/111°	-19°/-15°	4+	5	4	5	4+	3	3	4	4+	4-	4
1 mo Post-op	114°/115°	-3°/0°	4	5	5	5	5	4-	4-	4-	4-	4-	5
3 mos Post-op	126°/131°	1°/3°	5	5	5	5	5	4-	4-	5	4	4	5
6 mos Post-op	126°/131°	1°/1°	5	5	5	5	5	4	4+	5	5	4	4
1 year Post-op	123°/129°	1°/2°	4+	5	5	5	5	4+	4	5	5	4+	5

Table 1: Left Lower Extremity Measurements Taken at Each Follow Up Period.

Performance based outcome measures

Comparative values for the SLST, TUG, FSST, and 6MWT from one week pre-operatively to one-year post-operatively are recorded in table 2, figure 2 and figure 3. Initial performance-based outcome measures revealed decreased static and dynamic balance, mobility, and general endurance. One month post-op, the patient exhibited further declines balance, mobility, and general endurance as evident by declines in the SLST (right and left, 2.0s), TUG test (11.5s), and 6MWT (318.20m). However, the patient did demonstrate an improvement in the FSST from 8.09 to 7.27 seconds. Throughout the post-op follow up period with regular participation in PT, the patient continued to demonstrate improvements in balance, mobility, and general endurance as evident by increases in the SLST (right 7.7s, left 35.3s), TUG (6.8s), FSST (6.05s), and 6MWT (525.10m).

Goals

Upon discharge, patient was compliant with HEP and reached 100% of his goals. Most notable being the completion of a 5k race (with walking sticks) in 52 minutes.

Follow up Period	SLST	
	L	R
1 wk Pre-op	11.7(4.93)	2.0(0.00)
1 mo Post-op	2.0(0.00)	2.0(0.00)
3 mos Post-op	28.7(2.31)	2.0(0.00)
6 mos Post-op	29.7(0.58)	5.3(0.06)
1 year Post-op	35.3(1.15)	7.7(0.58)

Table 2: Progression on the SLST. Three trials of each leg were assessed at each follow up session. Values are mean (std dev) of the three trials and are reported in seconds.

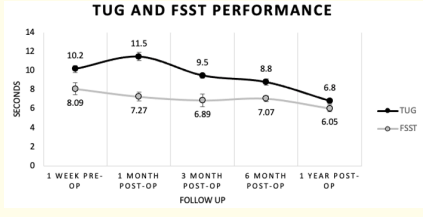

Figure 2: Progression on the TUG and FSST. Three trials of each outcome were assessed at each follow up period. Values are depicted as mean (std dev).

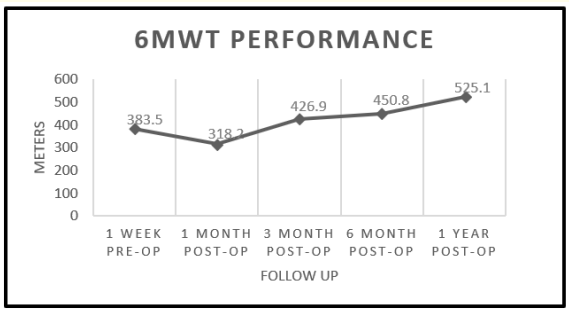

Figure 3: Progression on the 6MWT. One trial was completed at each follow up period.

Discussion

Patients with unilateral LEA are at increased risk for sound limb knee OA, which leads to pain and decreased function [1]. In this case study, pain in the sound limb pre-TKA resulted in decreased performance-based test measurements and outcome measures. There is currently a dearth of evidence demonstrating the course of rehabilitation and associated functional improvements in TFA patients post-TKA.

Range of motion and muscle testing

The American Academy of Orthopaedic Surgeons (AAOS) determined the normative range of motion for knee flexion and extension to be 135° and 10° respectively [5]. One year post-TKA, the patient achieved increased AROM and PROM for both knee flexion (126°/129°) and extension (1°/1°). Although the patient did not meet the normative average of knee AROM in adults, he did achieve active knee flexion between the necessary range of 100 - 120° required for running and gained the full knee extension required for normalized gait [11]. With TFA patients, hip muscle strength is a strong predictor of gait speed and dysfunction [1]. The patient's overall improvements in hip strength, specifically gluteus medius and minimus, likely contributed to a more normalized gait pattern. Hip extensor strength is the strongest predictor of prosthetic walking speed and likely attributed to increased scores on performance-based outcome measures, specifically the TUG and 6MWT. Strong hip abductors allow for proper lateral weight shift and normalized step length during gait [1].

Performance based outcome measures

The patient's initial SLST score on the right lower extremity was 2s, which could be due to lack of ankle and hip strategies on the prosthetic limb and is indicative for risk of falls. The patient was unable to achieve scores equivalent to 38.1s however, both sides achieved increased time on the SLST (right 7.7s, left 35.3s). Therefore, the risk of a fall may still be a factor; however, balance improved [7].

The mean TUG score of community dwelling adults 60 - 69 years old is eight seconds, with a score of greater than 19s indicating fall risk [1,7]. The patient was able to decrease his TUG score to 6.8s demonstrating a reduced risk of falls secondary to improvements in mobility and balance. In addition, he decreased his FSST score to 6.05s which is less than that of those 50 - 65 years old (7.49s), indicating he is not a fall risk [8]. Notably high intensity, versatile whole-body strength training paired with standard post-TKA PT likely contributed to this patient's ability to achieve functional levels of an age and gender matched non-amputee on the TUG and FSST. New research demonstrates that patients performing the FSST while wearing a Genium microprocessor knee (12.00s) performed better than standard grade microprocessor knees (C-Leg, 12.26s) [13].

Initially when completed, the patient completed 383.5m in the 6MWT, which is below the normative distance (572m) for males without amputations of similar age, weight, and height [7]. However, it has been found that patients with TFA are reportedly 43% slower than their healthy peers. Although the patient ambulated at a lesser distance, he did achieve an average gait speed (87.5 m/min) faster than is average for healthy adults (83m/min).[1] One year post-TKA, he increased distance walked (525.1m); however, he was still 108.0m short of the distance achieved by his non-amputee peers.

Goals

The patient's compliance with HEP and PT were expected to be above normal due to his occupation and likely contributed to suc-

cessful achievement of all goals. In particular, the patient did complete a 5k race with walking sticks in 52 minutes (eight minutes faster than his goal of 60 minutes).

Limitations

This case study allowed a detailed exploration of a proficient transfemoral prosthesis user's post-TKA course of rehabilitation. However, case reports commonly do not afford statistical analyses, calculation of effect sizes and generalizability to the larger clinical population. Studies with larger samples describing the outcomes of total joint arthroplasty in patients with LEA are needed to determine the potential benefit of these procedures in this patient population.

Conclusion

Following total knee arthroplasty, this patient, who was already a proficient transfemoral prosthesis user, was followed for a year post-operatively. In addition to range of motion and strength testing, outcome measures included SLST, TUG, FSST and 6MWT. Marked improvements were noted in range of motion, strength, and the TUG and FSST. Although the patient did not achieve the magnitude of values reported for non-amputees in the SLST and 6MWT, significant improvements were seen. Ultimately, the patient achieved unlimited community ambulation including exercise and activity participation beyond normal locomotion.

Results of the patient with unilateral TFA and contralateral TKA provide evidence of the importance of comprehensive standard-of-care PT paired with functional training augmented by a high intensity, versatile whole-body strengthening. This allowed for a more enhanced ability to perform all ADLs and mobility post-TKA. Further research is required to establish rehabilitation protocols specific to this population of patients.

Disclosure

This work was unfunded and represents the opinions of the authors and does not necessarily reflect the official position of any academic institution, the US Department of Veterans Affairs or the US Army.

Bibliography

1. Lusardi M., *et al*. "Orthotics and Prosthetics in Rehabilitation". 3rd ed. St. Louis, MO: Amirsys/Elsevier Saunders (2013).

2. Angoules A., *et al*. "Necrotising fasciitis of upper and lower limb: a systematic review". *Injury* 38 (2007): S18-25.

3. Heidari B. "Knee osteoarthritis prevalence, risk factors, pathogenesis and features: part I". *Caspian Journal of Internal Medicine* 2 (2011): 205-212.

4. Bae T., *et al*. "Dynamic analysis of above-knee amputee gait". *Clinical Biomechanics* 22 (2007): 557-566.

5. Norkin C and White D. "Measurement of Joint Motion A Guide To Goniometry". 4th ed. Philadelphia, PA: F.A. Davis Company (2009).

6. Kendall F., *et al*. "Muscles Testing And Function With Posture And Pain". 5th ed. Baltimore, MD: Lippincott Williams and Wilkins (2005).

7. Shirley Ryan Ability Lab. Sralab.org. https://www.sralab.org.

8. Langford Z. "The four square step test". *Journal of Physiotherapy* 61 (2015): 162.

9. Reid L., *et al*. "Going Places: Does the Two-Minute Walk Test Predict the Six-Minute Walk Test in Lower Extremity Amputees?" *Journal of Rehabilitation Medicine* 47.3 (2015): 256-261.

10. Bellew J., *et al*. "Michlovitz's Modalities for Therapeutic Intervention". 6th ed. Philadelphia, PA: F.A. Davis Company (2016).

11. Agrillo J., *et al*. "Rehabilitation Protocol: Total Knee Arthroplasty (TKA)". Lahey Hospital and Medical Center (2015).

12. Neumann D., *et al*. "Kinesiology Of The Musculoskeletal System". 3rd ed. St. Louis, MO: ELSEVIER (2017).

13. Gouelle A and Highsmith M. "Compléter l'interprétation Des Tests Cliniques Usuels Par Analyse Métrologique: Performance et Stratégie au Four Square Step Test Chez L'amputé Transfémoral". *Neurophysiologie Clinique* 48 (2018): 328-329.

Assets from publication with us

- Prompt Acknowledgement after receiving the article
- Thorough Double blinded peer review
- Rapid Publication
- Issue of Publication Certificate
- High visibility of your Published work

Website: www.actascientific.com/

Submit Article: www.actascientific.com/submission.php

Email us: editor@actascientific.com

Contact us: +91 9182824667