Technology and Innovation, Vol. 23, pp. 1-7, 2024
ISSN 1949-8241 • E-ISSN 1949-825X
http://dx.doi.org/10.21300/23.2.2024.11
www.technologyandinnovation.org

FUNCTIONAL IMPROVEMENTS MEASURED BY THE CONTINUOUS-SCALE PHYSICAL FUNCTIONAL PERFORMANCE TEST IN A UNILATERAL TRANSFEMORAL AMPUTEE FOLLOWING SOUND SIDE KNEE ARTHROPLASTY: A CASE STUDY

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Osteoarthritis is common in the sound limb of persons with a transfemoral amputation (TFA) due to gait abnormalities and increased load on the knee when ambulating with or without a prosthesis. Commonly, a sound-limb total knee arthroplasty (TKA) is required to decrease pain and improve physical function. This case report discusses physical functional outcomes in a person with a TFA following sound limb TKA as measured by the Continuous-Scale Physical Functional Performance Test 10 (CS-PFP 10).

A patient with a right TFA underwent a left TKA to improve functional performance. The purpose of this case was to quantify functional changes measured by the CS-PFP 10 at one week pre-TKA and one, three, six, twelve, and eighteen months post-TKA. Skilled standard care physical therapy was immediately implemented post-TKA, which included therapeutic interventions and electrotherapeutic modalities. Additionally, a whole-body high-intensity strengthening program was introduced at eighteen weeks post-operative (post-op) as an adjunct to return the patient to his prior level of function as a CrossFit® athlete.

All five CS-PFP 10 domains demonstrated continuous improvement, while the rate of perceived exertion decreased. At one week post-op, the patient's CS-PFP 10 score indicated an increased likelihood of functional dependence. However, by eighteen months, the patient achieved a total CS-PFP 10 score in the 75 to 90 range, indicating independent function likely.

The CS-PFP 10 is a valid instrument to measure improvement in activities of daily living (ADL) in specified functional domains and overall function. Following this patient post-operatively through rehabilitation, the CS-PFP 10 revealed objective improvements demonstrating that sound limb total joint arthroplasty and physical therapy can greatly improve function. These interventions are a viable course of treatment in the presence of contralateral functional impairment in patients with TFA.

The CS-PFP 10 is a valid instrument to accurately measure improvements in ADLs in specified functional domains and overall function in the patient population with a TFA following sound limb TKA.

Key words: Lower extremity amputation; Necrotizing fasciitis; Osteoarthritis; Rehabilitation; Transfemoral amputation; Total knee arthroplasty

Accepted: September 1, 2023
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INTRODUCTION

In the United States, there are approximately 185,000 lower extremity amputations (LEA) performed each year (1). In 2009, the health care costs associated with these amputations were over $8.3 billion (1). Amputations are performed on patients with diabetes, vascular disease, cancer, infections, trauma, and congenital limb deficiencies. Patients with unilateral transtibial and transfemoral amputation (TFA) are at risk for sound limb knee osteoarthritis (OA) (1). Late-stage OA is a chronic and degenerative synovial joint condition that primarily affects articular cartilage and presents with persistent pain as a result of the narrowing of the affected joint (2).

Dynamic analysis of gait in a patient with a unilateral TFA demonstrated decreased gait speed, stride length, altered cadence, and increased time in the sound limb stance phase (3). Abnormal gait patterns and joint mechanics coupled with a lack of prosthetic confidence increase the risk for sound limb knee OA (1). Currently, there is a lack of research regarding the functional performance of patients with LEA. Research related to functional assessment in LEAs using the Continuous-Scale Physical Functional Performance Test 10 (CS-PFP 10) is even more limited (4,5). The purpose of this case study is to measure improvements in activities of daily living (ADLs) following sound limb total knee arthroplasty (TKA) in a patient with TFA using the CS-PFP 10 test.

MATERIALS AND METHODS

Patient History

The patient was a 56-year-old male with a history of competitive powerlifting and CrossFit® participation. He contracted necrotizing fasciitis in the right knee while treating an infected patient as a physical therapist. The patient underwent fifteen limb salvage surgeries over three years; however, the infection returned, necessitating a TFA 5.1 cm above the right knee joint. Following his TFA, the patient began to experience insidious sound limb knee pain consistent with knee OA. Symptom management was attempted with physical therapy (PT) for approximately three years but was proven unsuccessful. A diagnosis of OA was confirmed with imaging (Figure 1), and thus a TKA was recommended.

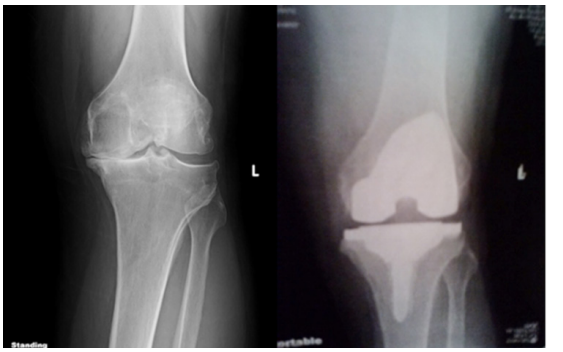

Figure 1. The left image is an X-ray of the sound limb knee prior to TKA showing significant OA between the medial femoral condyle and the medial tibial plateau. The right image is an X-ray of the sound limb knee following TKA.

Goals

Following TKA, patient-centered goals were established with a physical therapist; these goals included decreasing left knee pain and swelling as well as improving overall muscle strength, function, and independence with ADLs. In addition to therapy-specific goals, the patient had a personal goal of walking a five-kilometer race with walking sticks in under sixty minutes.

Intervention

The patient underwent a sound limb TKA using a Triathlon (Stryker, Kalamazoo, MI, US) Total Knee System prosthetic surgical implant. A midline incision was made over the patella, and dissection was carried down into subcutaneous tissue; a medial parapatellar arthrotomy was utilized to gain access to the knee. Immediately post-op, a plan of care for PT two times per week for thirty-three weeks was established and included patient education involving a home exercise program, an explanation of exercises, and a timeline of pre- and post-op interventions. PT interventions included stretching exercises, strengthening exercises, joint mobilization, gait training, and electrotherapeutic modalities.

The initial eight weeks of PT focused on standard post-TKA treatment. This included soft tissue and scar tissue mobilization, instrument-assisted soft tissue mobilization, range of motion exercises, lower extremity and pre-gait therapeutic exercises, and electrotherapeutic modalities (6,7). Passive manual and active assisted stretching were implemented

to improve active range of motion and passive range of motion in the patient's sound limb knee. Lower extremity therapeutic exercises and pre-gait activities were implemented to improve strength. Additionally, cryotherapy and interferential electrical stimulation were utilized to manage pain, edema, and effusion (7).

During weeks 9 to 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, Bosu® ball balance exercises, and side-stepping exercises with and without a handrail. Gait and balance impairments were addressed using single-leg stance, tandem stance, dynamic tandem walking, treadmill walking with upper extremity support, stepovers, and uneven surface walking.

In weeks 18 to 33, PT included outdoor obstacle course activities. These sessions included commando crawling (9.1 m), flipping industrial tires and carrying telephone poles (30.5 m), walking on a 4.6 m slackline (1.83 m from the ground) with arm support, scaling a 2.4 m wall, navigating a 4.6 m balance beam (0.4 m from the ground) with no upper extremity assistance, and dragging a 22.7 kg cement ball (61.0 m). Sessions began with one repetition of each activity and progressed to five repetitions. Conventional indoor clinic-based PT interventions were continued as needed to address acute and post-activity pain and edema in the left knee.

After week 33, as part of the patient's continued rehabilitative progression and personal interest in returning to higher-level physical activity, he began independent obstacle course training for twenty weeks with supervision from a physical therapist. This unique PT regimen was planned by a licensed physical therapist and is not considered standard physical therapy for a post-op patient with a TFA and with TKA. The patient participated in this training twice a week, with five components of the obstacle course performed each session. Following this training, the patient achieved his personal goal of completing a five-kilometer race with walking sticks in under sixty minutes.

CS-PFP 10 Test

This outcome measure is a physical performance test that has been determined to be a sensitive, valid, and reliable tool in patient populations that include, but are not limited to, individuals who are post-TFA, post-stroke, with cardiac disorders, with Parkinson's Disease, frail, or elderly (8). The test consists of ten standardized ADLs that evaluate overall physical functional performance (PFP) in five individual domains: upper body strength (UBS), upper body flexibility (UBF), lower body strength (LBS), balance (BAL), and endurance (END) (8). A score was established utilizing these five domains to indicate the functional performance in a patient with a TFA and with sound limb TKA (Table 1). It is one of the few outcome measures implemented for persons with TFAs using physiological capacity measures such as reaction time, range of motion, oxygen consumption, and peak torque (5). In addition, it has been used to determine functional differences in a sample of TFAs while utilizing two different prosthetic knees in a crossover study (4). In this case study, CS-PFP 10 was used to measure functional change longitudinally at the time points of one week pre-op and one, three, six, twelve, and eighteen months post-intervention.

Table 1. CS-PFP 10 Score Interpretation (8)

Score	Indication
57-100	*Independent function likely*
48-56	*Likely at risk of losing independence*
0-47	*Increased likelihood of functional dependence*

RESULTS

At one month post-op, all CS-PFP 10 domain values decreased except for UBS and LBS. By three months post-op, all domains and the overall PFP score plateaued; however, LBS, END, BAL, and the PFP score increased between six and twelve months post-op (see Table 2 and Figure 2). Comparing the post-op outcomes at one month and twelve months, all PFP scores increased incrementally by 28.5%. In addition, the patient's rate of perceived exertion (RPE) reduced throughout the eighteen-month post-op period.

DISCUSSION

As observed in Table 2, domain and overall CS-PFP 10 scores demonstrated considerable improvements across five repeated assessments eighteen months post-op. Initial higher domain scores

Table 2. PFP Domain and Overall Scores

	1 wk pre-op 02/07/2014	1 mo post-op 03/28/2014	3 mos post-op 06/25/2014	6 mos post-op 08/26/2014	12 mos/1-year post-op 02/01/2015	18 mos/1.5-year post-op 09/23/2015
PFP	48.9	47.8	70.1	68.3	76.3	74.3
UBS	62.2	69.0	91.8	91.4	93.1	93.1
LBS	43.0	44.1	65.6	64.6	70.6	71.1
UBF	60.4	57.1	79.0	76.9	80.7	80.7
BAL	47.3	44.5	67.1	64.4	74.4	71.7
END	46.8	43.0	65.4	63.4	74.3	70.1
RPE	15	14	12	11	12	10

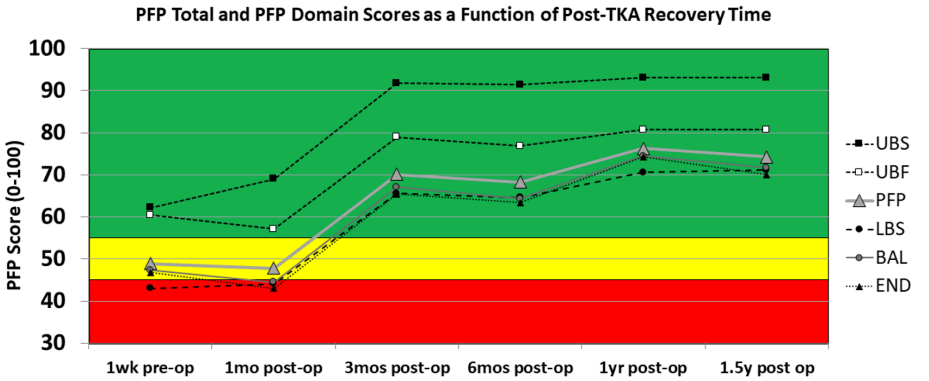

Figure 2. This graph represents the PFP total and PFP domain scores.

in UBS and UBF can be attributed to the unrelated nature of these domains with the surgical procedure performed. All the remaining initial domains fell in the range indicating an increased likelihood of functional dependence (0 to 47.9); however, the initial total CS-PFP 10 score falls in the category of likely at risk of losing independence (48 to 56). These results were likely skewed due to the high scoring of the initial UBS and UBF scores. In addition, the patient's RPE decreased across the five repeated post-op assessments, indicating less difficulty with activities as well as improvements in endurance and overall well-being.

Decreases in CS-PFP 10 domain scores between the one-week pre-op visit and one-month post-op visit may be attributed to post-operational effects such as inhibition of muscle activation due to pain and swelling, post-op weakness, and fatigue. All scores, including total PFP and individual domains of the CS-PFP 10, improved starting at one month post-op. The most notable increase in the PFP total score and all CS-PFP 10 domains occurred between one and

Table 3. Various Diagnostic Groups and associated CS PFP 10 Total Scores (9-14)

Diagnostic Group	CS-PFP 10 Total Score*
Current Case: TFA post TKA (1.5y) plus high intensity training	74
Non disabled 35-44yo (9)	74
Non-impaired control group for TFA study (10)	73
Non disabled 45-54 yo (9)	71
Female control group for females with fibromyalgia (11)	66
Non disabled 55-64yo (9)	63
Parkinsons Disease 45-54 yo (9)	61
Transfemoral Genium Knee Prosthesis Users (10)	60
Non disabled 65-75yo (9)	59
Parkinsons Disease 55-64yo (9)	56
Heart Failure - Post Aerobic & Resistive Exercise Training (12)	56
Transfemoral C-Leg Knee Prosthesis Users (10)	55
Females with Fibromyalgia (11)	49
Elder females 59-91yo (11)	49
Non disabled 75-85yo (9)	48
Manual Wheelchair users (13)	41
Heart Failure - Post Stretching & Flexibility Training (12)	39
Stroke survivors (14)	17

*Scores rounded to the nearest whole number for simple comparison.

three months post-op. During the six- to twelve-month post-op period, LBS, END, BAL, and PFP total scores substantially increased again, potentially due to the whole-body high-intensity strengthening program implemented to return the patient to his prior level of function. Scores at the twelve- and eighteen-month post-op assessments indicated that independent function is likely. The slight decrease in the END and BAL CS-PFP 10 domains at the eighteen-month post-op assessment affected the total PFP score. This decrease in END and BAL domains is attributed to the patient not continuing to perform the high-intensity versatile whole-body strengthening in a regimented fashion following discharge from physical therapy twelve months post-op.

These scores compare favorably with other diagnostic groups (Table 3). Initial scores for LBS and END in this case scored in the "increased likelihood of functional dependence" zone. This is comparable to prior PFP scores in those who use wheelchairs and in some with heart failure. By the conclusion of standard therapy and high-intensity training, the case subject was functioning at an "independent function likely" level, commensurate with non-impaired individuals aged 35 to 64, a group of community ambulators using Genium knee prostheses and higher functioning patients with Parkinson's Disease.

Work done previously by Highsmith et al. has

shown significant changes in the CS-PFP 10 functional performance scores in patients with a TFA while using two different microprocessor knee systems. There is evidence that this instrument is sensitive to changes in function and suitable to determine change in this case study (4).

LIMITATIONS

The patient's experience with prosthetic gait, use of an advanced microprocessor knee, and introduction to a whole-body high-intensity strengthening program following conventional PT may be unique and are therefore regarded as potential confounders in this case report. Furthermore, case reports are limited as they often lack the ability to generalize their findings to the larger population.

CONCLUSION

Although the total PFP score and the LBS, BAL, and END domains of the CS-PFP 10 did not achieve the magnitude of values reported for non-amputees, considerable improvements were observed, and the patient achieved unlimited community ambulation. This case report demonstrates the importance of comprehensive standard-of-care PT paired with functional training. Although a high-intensity versatile whole-body strengthening program was implemented for this specific patient to return to his prior level of function as a CrossFit athlete, a program such as this one could benefit other LEAs as well. This combination of therapeutic interventions post-TFA and sound limb TKA may have directly resulted in the ability of the patient to perform all ADLs in the independent function likely (57 to 100) CS-PFP 10 domain category. Further research is required to establish rehabilitation protocols specific to this patient population.

ACKNOWLEDGMENTS

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

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