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Prosthetic Training following a Transfemoral Amputation: A Case Report

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PROSTHETIC TRAINING FOLLOWING A TRANSFEMORAL AMPUTATION: A CASE REPORT

by

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This Scholarly Project, submitted by Jonathan Beck in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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(Graduate School Advisor)

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ABSTRACT

Background and Purpose: There has been an increase in amputations since the start of the Iraq/Afghanistan war, but thousands of Americans have a limb amputated each year due to peripheral vascular disease, diabetes, or infections. New technology in the field of prosthetics, especially prosthetic knees, has helped improve these individuals' function. The most recent advancement in prosthetic knees is the C-leg, a micro-processor-controlled knee; however, a wide variety of prosthetic knees are available. Therefore, it is critical to select the right prosthetic knee to meet each individual's needs and goals. **Case Description:** The patient was a 58-year-old gentleman who underwent surgery to amputate his leg above the knee due to vascular deficiency and the development of reperfusion and compartment syndrome in his leg. **Intervention:** He underwent six weeks of preprosthetic training before he was fitted for prosthesis. He underwent two weeks of prosthetic training rehabilitation to improve prosthetic care, wear time, balance activities, and ambulatory skills. **Outcomes:** He increased his wear time to 12 hours, improved his balance, extended his ambulatory capability to 500+ ft using a front-wheeled walker and negotiated 20 stairs using a handrail and crutch. **Discussion:** Initially it was thought the C-leg may benefit this individual, but following his six-month re-evaluation this was not the case due to a decreased activity level and also due to reduced

sensation of the sound limb. There is a general lack of research studies to show the benefits of C-legs in older individuals.

Key Words: Transfemoral amputation, prosthesis, C-leg

CHAPTER I

BACKGROUND AND PURPOSE

There has been recent advancement in prosthetic knees over the past decade. In 1997, Otto Bock introduced the C-leg in order to improve individuals with transfemoral amputation's function and quality of life. The C-leg is a microprocessor-controlled knee that uses software and sensors, which are placed throughout the prosthesis to constantly measure the flexion angle and angular speed of the prosthesis, thus predicting the gait of an individual with an amputation. The sensors relay the information to the microprocessor which analyzes the information using algorithms to make an appropriate decision to flex or extend the knee. The hydraulic cylinder then acts on this decision by regulating the amount of fluid present, thus affecting the level of resistance that is needed to flex or extend the knee.[1]

This new technology gives individuals with transfemoral amputations the ability to walk with a more natural gait, as they do not have to concentrate on each step. It has decreased the number of falls when walking on uneven surfaces or when they alter their cadence.[2] It also allows individuals with an amputation to use a step over step gait on stairs, rather than a step-to gait.[3]

Several studies have compared the C-leg to other mechanical knee joints. Most studies agree that the C-leg improves an individual's safety and level of function by

improving the response of the swing phase and the ability to alter the gait speed. The C-leg also reduces the amount of energy required to ambulate compared to other prosthetic knees.[4,5]

A study by Blumentritt et al[4] was performed to compare the safety of the C-leg against two other hydraulic knees in real world situations, such as walking on even ground, abruptly stopping or sidestepping, stepping on an object, and tripping. This study gave evidence that the C-leg reached its full extension faster than the other two hydraulic knees and was the only prosthetic knee to demonstrate an external flexion moment to decelerate the leg and improve the individual's posture and stability, thus reducing the number of falls in individuals. These results help to show the safety of the C-leg by preventing falls in real world situations.

There has been an increase in prosthetic rehabilitation taking place over the past several years, as numerous soldiers are traumatically losing limbs from roadside bombs in Iraq and Afghanistan. These individuals have the advantage of being young, active and motivated in achieving their goals; therefore, these individuals are more ready to benefit from the use of a C-leg. On the other hand, thousands of older, less active individuals suffer from lower extremity amputations each year due to complications such as diabetes, peripheral vascular disease, infections, and cardiovascular diseases.[6] Unfortunately, there have been few, if any research studies performed on the benefits of using a C-leg with older individuals with amputations.

Each individual with an amputation has the ability to obtain a prosthesis. However, assistance from insurance companies may be needed to help cover the cost of

the prosthesis. Medicare and Medicaid developed K levels in order to rate functional levels and determine the need for a prosthesis in individuals with a lower extremity amputation. These levels are based on the individual's age, perambulatory skills, comorbidities, and rehabilitation goals prior to receiving their prosthesis. The K-levels assigned include: level 0, the individual has no need or use of a prosthesis; level 1, the individual will ambulate on even surfaces; level 2, the individual can go up and down curbs and stairs, level 3, the individual can ambulate at variable cadence; and a level 4, the individual represents an athlete who ambulates with high impact, stress and energy levels.[6]

Here is a brief example of how Medicare and Medicaid incorporate the K-levels to each individual. If the individual was assigned a K-level of zero, the insurance may cover the cost for a cosmetic prosthesis but would not cover the higher cost of a C-leg because this individual would not benefit from it. On the other hand, if an individual has been assigned a K-level of four, the insurance is more likely to cover the expense of a C-leg to improve the individual's function.

The components for a transfemoral prosthesis include the socket, prosthetic knee, pylon, and ankle. The socket is the interface between the residual limb and the prosthesis. The socket can be attached to the residual limb by either using the gel liner suction system with strap and buckle to prevent it from sliding around or through the use of a suspension sleeve that wraps around the leg or other hip to hold it in position.[7]

The main function of the knee joint is to give an individual the support necessary in the stance phase and the ability to transition smoothly in the swing phase.[7] There are

several types of prosthetic knees on the market, each having its own advantages and disadvantages. Therefore, it is important the CPO (certified prosthetist/orthotist) and physical therapist (PT) communicate with the patient and insurance companies to choose the most appropriate prosthetic knee for this individual.

The simplest knee is the single axis knee or hinge joint. This knee allows the safest ambulation for individuals with a transfemoral amputation; however, the individual will need to unlock the knee prior to sitting down. The single axis constant force knee is durable and low-maintenance; however, it has a single cadence and no stance control. The polycentric knees have multiple centers of rotation that provide the individual with better control of the prosthetic knee and the polycentric without fluid control knee is ideal for individuals who have weak hip extensors. The SAFE knee or weight-activated knee provides stability in the stance phase because the knee cannot be flexed during weight bearing, as this produces friction that prevents the knee from buckling. This makes it safer to ambulate on uneven surfaces. The last classification of prosthetic knees is the hydraulic knee, an example being the C-leg as previously mentioned. The hydraulic knees are the most advanced knees on the market, but are also associated with a higher monetary value. Therefore, it is critical to emphasis the importance of utilizing the C-leg to ambulate long distances and to walk on uneven terrain or stairs on a daily basis.[7,8]

The pylon is a simple tube or shell that attaches the socket to the terminal device. The two main categories of pylon are the exoskeleton and endoskeleton. The exoskeleton has a hollow shank with the individual's body forces placed on the outside walls. The exoskeleton pylon looks and feels more natural, but is harder to maintain. The

endoskeleton has a tube that holds the body forces. The endoskeleton is easier to maintain, but does not look as natural because foam covers the tube.[7]

The importance of the prosthetic ankle is for stability, shock absorption, and replacement of muscle function. The single axis foot adds passive plantarflexion (PF) and dorisflexion (DF), thus improving the stability of the individual. The multi-axis foot allows motion in all axes of the foot and is recommended for individuals who walk on uneven surfaces. The solid ankle-cushion heel (SACH) is used in a majority of individuals because of the soft rubber heel that compresses with each step, thus mimicking PF and allowing for a smoother gait.[7, 8]

The purpose of this case report is to monitor the progression of a 58-year-old patient with a transfemoral amputation after receiving his initial prosthesis (gel liner suction system, OFM2 hinge knee, endoskeleton pylon, SACH ankle) and to observe whether or not the C-leg would benefit him on a long-term basis. A detailed description of his prosthetic rehabilitation will be discussed and analyzed. Upon completion of physical therapy and after careful review of clinical evidence, this individual did not attempt to use the C-leg prosthetic knee as the costs outweighed the benefits for this patient. This decision was based on his decreased activity level and decreased sensation in his sound limb but also related to inadequate amounts of research in regards to the benefits of a C-leg in older individuals with amputations.

CHAPTER II

CASE DESCRIPTION

The patient was a 58-year-old Caucasian male. He was 170 cm tall and weighed 49.64 kg. He lived in an apartment by himself but stated his son lived nearby and was willing to provide assistance as needed. He has recently retired from his previous occupations of a farmer and a plumber. He also served in the Navy during the Vietnam War.

In June 2009 this individual was diagnosed as having a deep vein thrombosis (DVT) in his left calf, and had stents placed in his left common iliac artery to improve blood flow. However, following his surgery he developed reperfusion and compartment syndrome that lead to the transfemoral amputation of his left leg on June 22, 2009.

He was the optimal patient for this case report because he is an older gentlemen staying at the Fargo Veterans Affair Hospital (3rd Floor Community Living Center). While staying at the VA Hospital he came down to physical therapy on a regular basis for 6 weeks of preprosthetic training followed by 2 weeks of prosthetic training to improve his function using the prosthesis. He was also at a level which determined that he may or may not benefit from receiving a C-leg prosthetic knee in the future. Therefore, the purpose of this study, as discussed previously, was to determine the benefits of a C-leg in an older individual, as it has been illustrated that there are very few studies on older

individuals with amputations. This case report and, specifically this patient, would assist in determining if a C-leg does, in fact, benefit an older individual such as the one currently being discussed.

Prior to his amputation his past medical history was unremarkable, except for his diagnosis of alcoholism and use of tobacco, which would delay his healing by reducing blood flow and oxygen to the tissue.[9] However since his amputation he suffered from hospital-acquired pneumonia, septic shock, renal failure requiring dialysis and malnutrition of a mild degree. He did not have a history of psychological disorders but did appear to be depressed for a short period of time following his amputation due to self-image issues and his lack of ambulatory skills. However, no formal assessments were performed to measure his level of depression; but depression is common in people with amputations (some studies show as high as 41%), because losing a limb is a life-changing event that affects an individual both physically and mentally.[10] They have to adjust to their new appearance and relearn several skills; however, his level of depression lessened during rehabilitation as he learned new skills and was able to ambulate again.[9,10,11]

The patient states his goals for rehabilitation were to learn to walk again using his prosthesis, and to perform as many daily activities as he can. These are reasonable goals this patient has set for himself.

Examination

We assessed the residual limb for proper shape, healing, and appearance prior to the individual getting fitted for his prosthesis.[11] The residual limb had a conical shape appearance and no adductor roll was present. The temperature of the residual limb was

compared to the sound limb by touch, as no thermometer was present. Sensation was tested throughout the residual limb using light and deep touch.[11] The temperature was within normal limits and equal bilaterally and no alterations of sensation were noted. The incision site was in the remodeling phase of healing with no drainage apparent. A slight redness was present around the incision site but no tissue adhesions or tenderness were noted.[12,13] The remainder of the residual limb did not have any significant redness or skin breakdown which could indicate blisters or pressure sores.

Before his amputation he was able to perform all activities of daily living (ADLs), ambulate functional distances of 3000 ft, and negotiate stairs with modified independence using a single-point cane for comfort. He has been seeing physical therapy for preprosthetic training during the past 12 weeks and currently requires supervision for transfers and ambulates 150 ft using a standard walker under contact guard assist (CGA). His blood pressure, heart rate, and oxygen saturation were within normal limits after this activity. The current medications he was taking included warfarin to help alleviate the deep venous thrombosis present in his right lower extremity and nutritional supplements such as calcium, vitamin D, folic acid, thiamine, and a multivitamin.

The patient had adequate range of motion in his residual limb, as no contractures (hip flexion or abduction) were noted; however, no formal measurements were taken. His residual limb strength was assessed by a formal manual muscle test to be 4-/5 for motions of hip flexion, extension, abduction and adduction and his resisted isometric movements (RIMs) were all strong and painfree, revealing adequate strength to function with a prosthesis.[14] Measurements were taken by the CPO, consisting of ischial tuberosity

distance to the floor, femur length and residual limb length, giving the CPO adequate information to fit the patient with an appropriate size shrinker sock. The circumference of the residual limb was measured at the greater trochanter and every 7 cm distally in order to monitor any changes in edema.[11,13]

Examination of the patient's right lower extremity (RLE) or sound limb was also assessed, as this would have increased stress and workload placed on it.[11] Skin condition, pulses and temperature were equal bilaterally; however, a decreased sensation of light touch was noted in his right foot. This is a main concern regarding the safety of the patient as well as the level of activity he will be able to achieve.

Based on this information, the PT and CPO agreed to use the medi OFM2 knee joint for the initial prosthesis. The benefits of this knee joint are the increase in safety for individuals with decreased function, and the ability to transition from a locked knee to a mobile knee by simply pulling a lever.[15] It was critical to monitor this patient's right foot sensation and activity level during the next several months, as this will help determine if a C-leg will benefit him in the future.

This patient came to physical therapy excited to use his new prosthesis but was apprehensive as well. The residual limb's skin integrity was thoroughly assessed again before donning the prosthesis, in order to compare any differences in appearance after doffing the prosthesis. After donning the prosthesis, the patient's balance in sitting was assessed to be normal, as he maintained balance while a moderate amount of force was applied to his shoulders in all directions.[11] When it was time to stand for the first time with his new prosthesis, he was a little hesitant with fear and required minimal assist to

transition from sit to stand. He had decreased levels of balance in standing, which was evidenced by an increased amount of sway and the need for the parallel bars for external support. Upon observation, this individual's standing posture revealed a forward head, rounded shoulders, and feet slightly wider than shoulder width apart to increase his base of support. While holding on to the parallel bars for safety, he demonstrated weight shifts in all directions to improve balance, gain trust in his prosthesis and note the changes in his center of mass (COM) while using the prosthesis.[9,11] This was important for him to master because his COM would constantly change during ambulation with his prosthesis.[16]

The patient was educated on proper foot placement to improve his safety during ambulation. This consisted of taking small steps forward and backward using his prosthesis. Walking in the parallel bars was the next step in the process. A mirror was placed at the end of the parallel bars (20 ft) in order for the patient to see himself walk.[17] He required several verbal cues that included "keep looking up," "try not to circumduct your leg," and "stand up tall." The patient felt his prosthesis was "catching" during the swing phase of gait. This problem was analyzed and believed to be the main reason he was circumducting his prosthesis.[11]

The patient was able to walk 80 ft in the parallel bars; however, he reported some pain near the distal anterior portion of the residual limb as well as the proximal lateral part of the residual limb. After doffing the prosthesis the residual limb was assessed and slight redness was noted in these two areas. The patient monitored the redness and stated that it vanished rather quickly, within 10 to 15 minutes which is normal.[11]

Evaluation

Upon review of the assessment, the individual had adequate strength, range of motion, and shape of his residual limb; however, he needed to improve his level of function and safety using the prosthesis. Because of his lack of experience using his prosthesis, he demonstrated a decrease in balance and ambulatory skills, and had not yet attempted stairs. Prior to his discharge home, it would be important to improve these skills and his endurance to improve his function and QoL, as he was unable to perform ADLs such as cooking, cleaning, laundry, getting the mail and going to the store.

Prognosis and Plan of Care

The short term goals set for this patient following initial PT intervention were to demonstrate proper donning and doffing technique and explain proper care for prosthesis within two to three days, be able to tolerate wearing prosthesis at least two hours at a time within five to seven days, progress ambulatory skills from parallel bars to a standard walker and ambulate 75 ft under supervision within one week, and to attain modified independent status with prosthesis on level surfaces and stairs within two to three weeks.

The long term goals set upon completion of therapy included this individual being able to don/doff his prosthesis and take adequate care of it, wear his prosthesis for 12 hours a day to perform ADLs as needed, ambulate with modified independence using a front-wheeled walker (FWW) a functional distance of 500 ft and negotiate 10 stairs. He will also know signs and symptoms of a poor fitting socket through experience and patient education.

According to the Guide to PT Practice,[18] this individual falls in 4J practice pattern of impaired motor function, muscle performance, range of motion, gait, locomotion, and balance associated with amputation. The best ICD-9 code is 897.2, surgical amputation without prior notification. Another diagnosis code or medical diagnosis according to the VA medical center is V49.76 or amputation status of the lower limb above the knee.

The prognosis for this patient was good to be at the level of modified independent with ambulation on level and stairs using prosthesis with locked OFM2 prosthetic knee within 3 to 4 weeks, but the chance of receiving a C-leg in the future is fair as this will depend on his level of activity and the sensation of the sound limb's foot. He would be reassessed in six months to further evaluate if a C-leg would be beneficial. It would be beneficial if he improved his endurance and withstand ambulating at least 0.25 miles on a daily basis, and if he needed to ambulate on uneven terrain on a regular basis. However, if he is more a home dwelling individual with an amputation, which he was, the C-leg may not be the best choice for use.

CHAPTER III

Intervention

This patient came to physical therapy four times per day (8:00 am, 10:30 am, 1:00 pm and 3:30 pm) for prosthetic rehabilitation. The amount of time varied from fifteen minutes initially to 30 to 45 minute sessions before he was discharged two weeks later. He worked on his donning/doffing skills, increased wear time, and improved balance and ambulatory skills during these sessions.

He was educated on proper technique to don and doff prosthesis. The donning and doffing of each prosthesis is slightly different. This particular prosthesis had a gel liner with a strap and clip placed at the most distal part. The gel liner was initially rolled inside out and placed on the most distal aspect the residual limb. It was then rolled proximally over the rest of the residual limb, making sure no wrinkles were present. The strap was then inserted through the slot on the prosthesis, and was attached near the greater trochanter using the clip.

Doffing was performed in a reverse manner. The clip was unclasped, and the prosthesis was removed. The gel liner was rolled from proximal to distal until the entire residual limb was present. The skin integrity of the residual limb was assessed for redness and skin breakdown each time after doffing. These donning and doffing skills were practiced several times a day with supervision by the physical therapist.

The patient was educated on proper care of residual limb and cleaning techniques of the gel liner and prosthesis. The gel liner was flipped inside out and a clear, non-odorous, anti-bacterial soap was applied in small circles to clean the entire inside lining. The soap was then washed off using lukewarm water and dried overnight. This individual had two gel liners, so he was able to alternate his wearing schedule allowing each gel liner to completely dry. It was critical that the gel liners have no water residue present at the time of donning, as a warm, wet environment is ideal for bacterial breeding grounds and may promote an infection.[19] Water will also increase the amount of "slippage" of the gel liner on the residual limb, potentially causing skin irritation and breakdown.[19]

The prosthetic socket was also washed out each day using lukewarm water and anti-bacterial soap. It would air dry overnight, and be blown dry using a hair blow dryer in the morning to make sure no water residue was present prior to donning. These activities were performed each day to prevent skin irritation and breakdown.[6]

The wear time of the prosthesis was altered in small increments to allow the residual limb to adjust to the increased forces applied and also allowed the residual limb's skin integrity to be assessed each time the prosthesis was doffed. If any alterations to the skin integrity were noted such as redness or skin breakdown and these areas of irritation lasted for greater than 24 hours, his activity was halted and the CPO was contacted to alter the prosthesis as needed.

His inexperience to transition safely from sit to stand using the prosthesis was addressed and practiced. First, assessment of his wheel chair height revealed that his hips were above his knees, a position which would help decrease his level of energy needed

for this transition. [20] The wheelchair breaks were locked and the patient used medial/lateral weight shift to scoot to the front of the wheelchair. His feet were placed slightly behind his knees as he shifted his body weight anteriorly and pushed against the wheelchair's armrest to complete this transition. Once standing, he would gain his balance using his walker or the parallel bars for support. After he was steady in standing, he had to "lock" the knee joint by using his hamstrings on the residual limb to hyperextend the prosthetic knee into the locked position.

Sitting down was performed in a slightly different manner. When close to his chair the patient turned around facing away from the chair and took small steps backwards until he felt the chair. Again he held onto the parallel bars or walker for support. His hip extensors were used keep the prosthetic knee extended, and then he used his hand to pull the lever on the prosthesis, which allowed the knee joint to move freely. After the knee joint was unlocked, he reached back for the armrest and slowly lowered himself into the wheelchair.

On initial standing in the parallel bars he had an increased amount of sway related to a decrease in his balance; therefore, balance activities were performed to improve his balance. These included weight bearing through his prosthesis by standing, weight shifts, and by taking small steps. The first balance activity consisted of standing in parallel bars as he placed weight through his residual limb and prosthesis. He was encouraged to hold on to the parallel bars for support as needed. His forward head posture and rounded shoulders were corrected by verbal cues provided by the physical therapist.

Guided weight shifts were performed in all directions (anterior/posterior, medial/lateral, clockwise/counterclockwise) to improve balance and become accustomed to his dynamic center of gravity (COG) using the prosthesis. The COG is usually a bit higher, forward and to the side of the sound limb.[9] This exercise progressed as the PT applied a small force in random directions to his shoulders which altered his COG and required him to use his residual limb's muscle strength to regain his balance. This exercise was used to help him build trust and confidence in his prosthesis and reduce the risk of a fall. After he practiced and improved his balance and trust using the prosthetic device, the patient was informed to take small steps in the parallel bars. He was taught to use his quadratus lumborum and iliopsoas muscles to lift his pelvis and allow adequate ground clearance for his prosthesis to swing through. He placed all his body weight on the prosthesis as he took a small step forward with his sound limb. After he stepped back with the sound limb, he took a small step with the prosthesis. Verbal cues were used to correct his posture and place emphasis on using his quadratus lumborum and iliopsoas muscles.

Upon walking in the parallel bars for the first time, he was encouraged to use a step-through gait by taking a shorter step with the prosthetic leg and stepping past the prosthesis with the sound limb. This allowed for better control, ground clearance, and a more natural walking appearance. It would also help decrease the amount of energy exerted, as an individual with a transfemoral amputation already uses 60% to 70% more energy compared to an ambulatory without an amputation.[21] A mirror was placed at the end of the parallel bars to encourage the patient to look up and observe himself. This

allowed him to make his own corrections and improve his quality of ambulation. However, he felt his prosthesis was “catching” during swing phase, and demonstrated a common substitution pattern of circumducting his hip in order to clear the ground with his prosthesis.[8] Therefore, the prosthesis was believed to be too long and was further assessed by placing a shoe lift (0.25 in) in the sound limb’s shoe. As expected, this improved his quality of gait, so the CPO was contacted and removed 0.25 in of the pylon to make the prosthetic appropriate height to allow adequate ground clearance. After this problem was solved he improved his ambulatory time and distance and less verbal cues were needed.

After several repetitions in the parallel bars, the patient progressed to a standard walker. A standard walker was initially used because of his previous experience during preprosthetic rehabilitation and because of its added stability and safety compared to a front-wheel walker (FWW).[21] He was educated to continue using the step-through gait, taking a slightly shorter step with the prosthesis. He felt uncomfortable with this gait, as he had difficulty attempting to stop and lift the standard walker between strides, so he later attempted using a FWW to improve the quality of his gait.

Proper form using a step-to gait on the stairs was addressed, since he had six stairs in his apartment. He was initially educated to use both handrails for increased stability and support. Placing all his weight through his hands and prosthesis, he flexed his hip and placed his sound limb on the first step. He then placed his weight through his sound limb and used his hip elevation muscles to bring the prosthesis to the same step. This was repeated for the next several steps.[16, 20]

Coming down the stairs was performed as he used his hip elevation muscles to move the prosthesis forward and down onto the next step. He then placed his weight through his hands and prosthesis to provide stability as he lowered his sound limb to the same step. This again was repeated for the remainder of the steps.[16,20]

He practiced his balance skills using his prosthesis by ambulating in the parallel bars, but he used one handrail for support instead of two. Again he used a step-through gait with verbal cues to correct his posture. This allowed him to build trust and confidence in his prosthesis in light of his decreased stability.[9]

After several days of using the FWW and improving his balance in the parallel bars, he was instructed on using axillary crutches. Using crutches decreased his stability and base of support compared to using a walker.[20] A modified three-point gait was used with the two crutches and prosthesis moving together, touching the ground simultaneously as he stepped through with his sound limb. He also attempted to use one crutch placed in his right arm, opposite his prosthesis. He moved his prosthesis and crutch together and stepped through with his sound limb; however, he required moderate assistance for balance that was due to a decreased base of support from one crutch compared to two.[20]

He continued to practice his balance skills by standing unsupported in the parallel bars, while a therapist threw a ball that made him displace his COG in order to catch it. Another therapist was standing behind the patient to prevent a fall from occurring.

He practiced a real life situation of negotiating a hill by using his walker to maneuver up and down a ramp that was roughly 50 ft long with a 30-degree angle. He was educated to ambulate slowly using a step-to gait because his COG was displaced with each step.

He took a smaller step with his sound limb when going up the ramp, allowing adequate ground clearance for his prosthesis. However, when he progressed down the ramp he took smaller steps and led with his prosthesis before he brought his sound limb up to his prosthesis.

Another life situation addressed was using one handrail and one crutch to negotiate stairs because his apartment only had one handrail. Similar to what was previously described, he placed his weight through his hands (one on the handrail and the other using a forearm crutch) and stepped up using his sound limb. He brought his prosthesis up to the same step and progressed until he completed the stairs. He descended the stairs by supporting himself and placed his weight on his sound limb in order to progress his prosthesis down onto the next step. He then placed his weight through his prosthesis and hands as described earlier to bring his sound limb to the same step.[16, 20]

The patient met with an occupational therapist, from whom he obtained equipment such as a shower chair and a pouch for his walker to assist him with ADLs. Prior to discharge, he went on a weekend pass to his apartment with his son present to help if needed. He was educated on ways to decrease the risk of falls such as leaving a light on throughout the night, eliminating all throw rugs, and reducing clutter and cords.[9]

CHAPTER IV

OUTCOMES

The patient practiced his donning/doffing skills several times a day, and was able to independently don and doff his prosthesis in less than three minutes prior to discharge. During his prosthetic training and upon PT questioning, he demonstrated full awareness and knowledge to assess the skin's color and appearance of his residual limb. He would note any changes in appearance and stated he would seek professional help if they did not resolve themselves. He also demonstrated proper technique to wash his residual limb, along with cleaning his gel liner and prosthesis on a daily basis.

He improved the amount of time he was able to wear his prosthesis from four 15-minute sessions per day until he was able to wear it for 12 continuous hours. The rate of this progress can be viewed in Figure 1.

Initially he required minimal assist and several verbal cues to transition from sit to stand, but these skills improved with repetition and he was independent with this transition after the third day of physical therapy. While standing in the parallel bars for support, he improved his weight bearing time from one minute to five minutes the first day. Prior to discharge, he could either stand and/or ambulate for up to 30 minutes.

He improved his balance skills by adjusting his COG as needed in order to prevent a fall. He was able to walk the length of the parallel bars during the first session

of therapy; however, he required several verbal cues and a prolonged period of time (not actually measured) to complete this task. By the end of the first day, he was able to ambulate 80 ft in the parallel bars.

He continued to progress his ambulatory skills by using a standard walker after the first day in the parallel bars. He ambulated 80 ft the first time he used a standard walker, but he required several verbal cues to remind him to use a continuous gait and step past his other foot. He also required added support (provided by the PT) for safety.

By the end of the third day he ambulated up to175 ft using a FWW with supervision. He progressed this distance to 300 ft by day seven and 500 ft by day twelve. The distance he was able to ambulate without rest can be viewed in Figure 2. Note: The few days that he did not increase his distance were the days he worked on negotiating stairs.

He continued to work on his ambulatory skills daily, both with a FWW and/or in the parallel bars. He started to work on his balance by using one handrail in the parallel bars on the third day of rehabilitation. He progressed from 20 ft the third day of rehabilitation to 40 ft on the fourth day and 80 ft a couple days later. His progression of balance measured by the distance of ambulation in parallel bars using one hand can be seen in Figure 3.

He attempted the stairs during the last session of day three as well. He negotiated three stairs using both handrails three times and attempted using one handrail and one crutch to simulate his home environment. He progressed these skills each day and tried the stairwell on the eighth day of therapy. He negotiated 10 stairs using one handrail and

one crutch, but he required contact guard assist during the first two attempts. He improved his balance and skills until he was able to negotiate 20 stairs independently. His progression to negotiate stairs can be found in Figure 4.

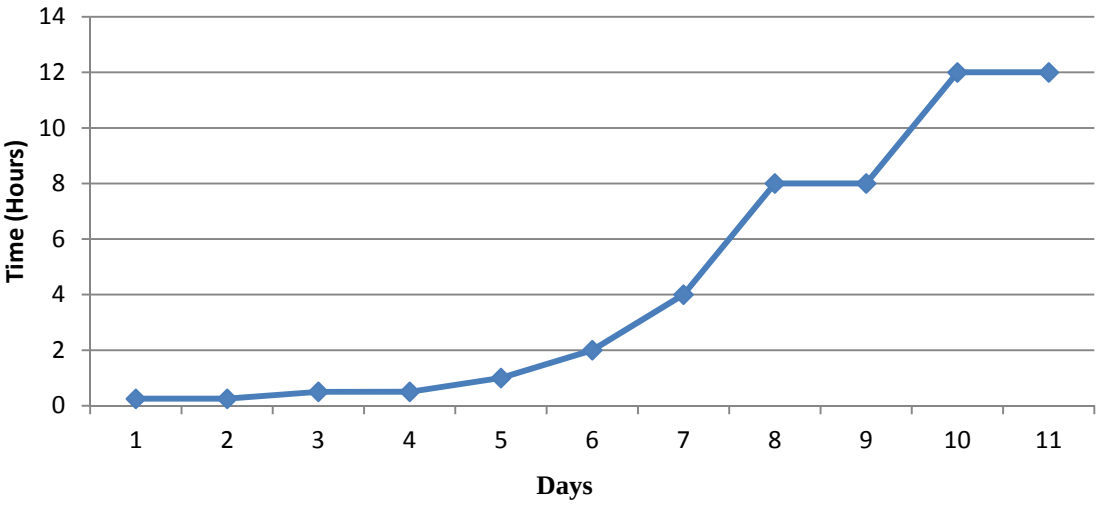

Figure 1. Amount of time this individual consecutively wore his prostheis each day.

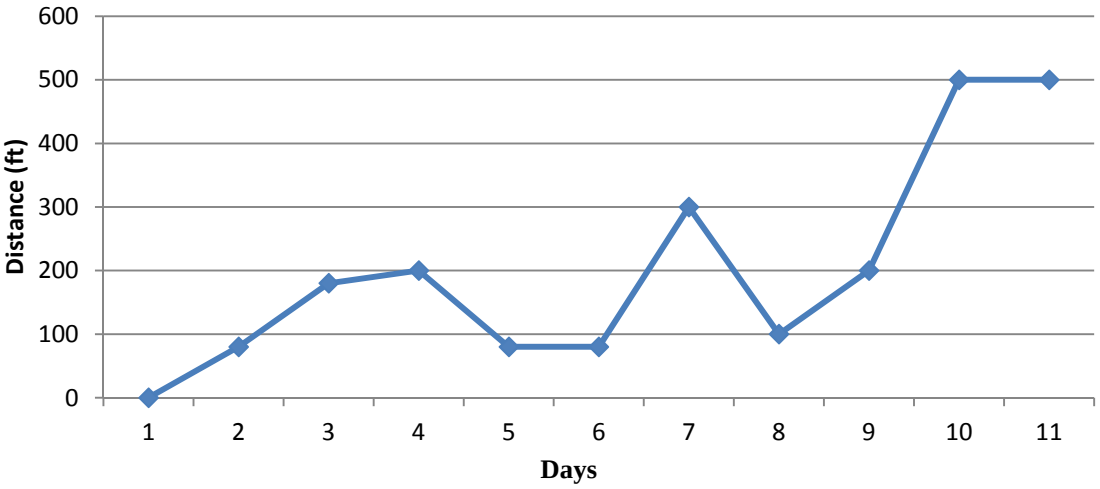

Figure 2. Distance of ambulation using a FWW without rest.

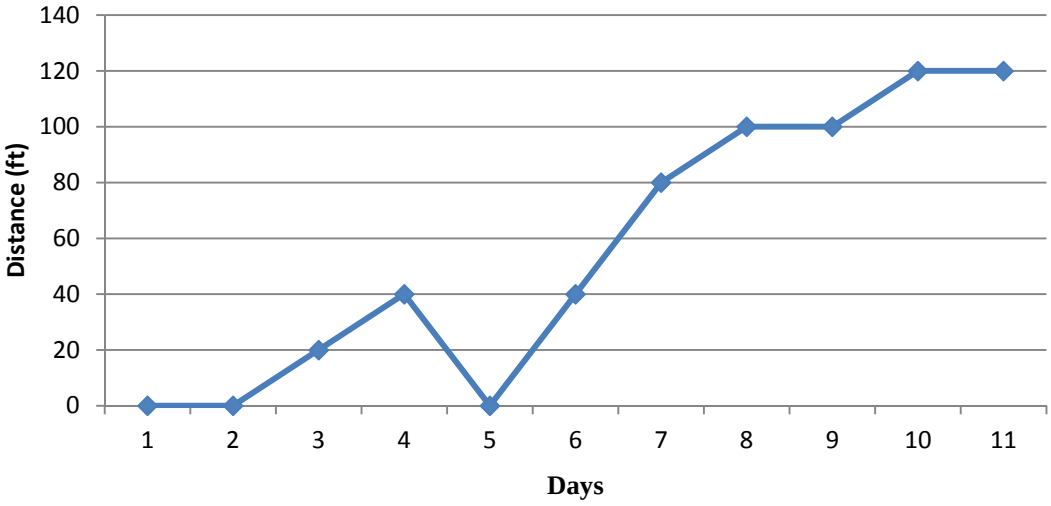

Figure 3. Distance of ambulation in parallel bars using one hand for support.

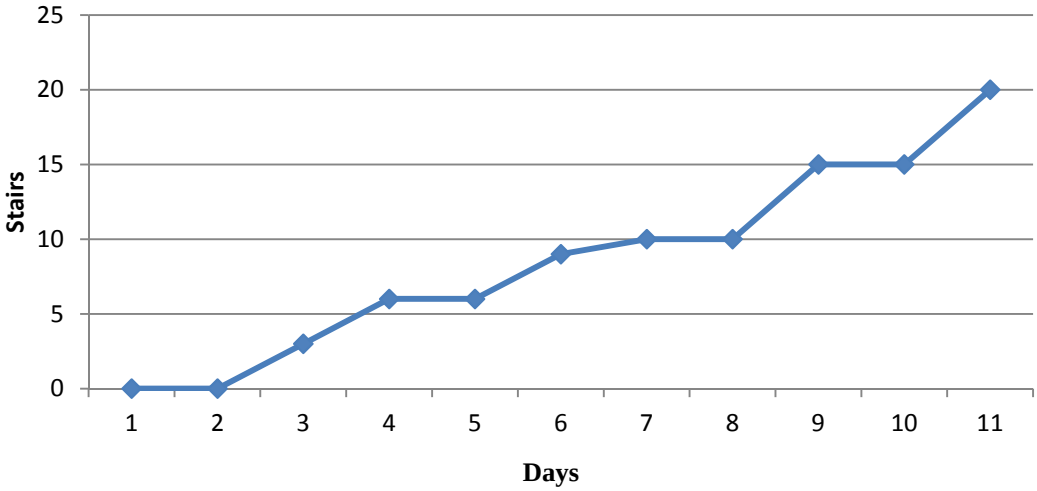

Figure 4. Number of stairs he was able to negotiate using one handrail and one crutch.

Since he was improving his balance and ambulatory skills using the FWW, he attempted to use axillary crutches on days eight and nine. He demonstrated decreased balance using the crutches, as he required moderate assist to ambulate; however, this helped determine that the best assistive device at this time was the FWW. These observations raised concern at this point whether a C-leg would improve ambulatory function in this patient.

He attempted the ramp on day nine. He negotiated it twice and required contact guard assist the first time, and only supervision the second time. The next day he negotiated the ramp faster and had greater stability compared to the previous day.

In regards to the weekend trial at home, the patient and his son thought it went very well. The patient stated, “I was able to go up and down the stairs without a problem, and was even able to get the mail.” He stated his son helped him move unreachable items in the kitchen into cupboards he could reach, and they placed night-lights in the hall. After hearing no concerns about the weekend trial, the patient was ready to be discharged from physical therapy.

Upon the six-month re-evaluation this patient appeared to be doing very well with the OFM2 prosthetic knee. His function improved since rehabilitation, and he was able to perform ADLs and ambulate around the community. However, he is mainly a home dwelling individual with an amputation with comorbidities like decreased sensation in the right LE. Therefore, the costs of receiving a C-leg outweigh the benefits for this individual and he chose to continue using the locked OFM2 prosthetic knee.

CHAPTER V

DISCUSSION

Regardless if an amputation occurred due to a traumatic incident or if it was needed to prevent future complications as in this case, an individual must overcome a wide variety of obstacles and relearn several skills that are essential in order to become functional. A large aspect of this training or education will occur in physical therapy. This is where the individual will work on stretching and strengthening exercises and may receive a prosthesis in the future.[11,13] However, there are a wide variety of prosthetic components on the market today including the C-leg prosthetic knee; therefore, it is important to customize each prosthesis and intervention program to the individual in order to safely achieve their highest level of function.[22]

The physical therapist will also play a key role during prosthetic rehabilitation where the individual improves personal skill using the prosthesis and increases level of function. However an individual's age, previous level of activity and number of comorbidities may alter an individual's rehabilitation and ability to return to function.[22]

This individual went through prosthetic rehabilitation to improve his level of function and quality of life using his prosthesis. The use of the OFM2 (hinge knee) was used as the initial prosthesis because of the increased safety of a hinge knee, and it was hoped to proceed to a C-leg to improve his level of function.[2]After the six-month re-evaluation and

other considerations, this individual would not be a prime candidate for a C-leg due to decreased activity levels[23] compared to younger individuals with amputations and decreased sensation in the sound limb. Therefore, he continued to use the OFM2 prosthetic knee.

The literature alluded to the concept that the C-leg prosthetic knee is more beneficial in more active, younger individuals with an amputation.[5] This assumption was correct when compared to this particular individual's findings, as he did not benefit from the C-leg in part due to a decrease in his functional activity that is related to aging.

There were several major factors that contributed to this particular individual's improvement using his prosthesis to ambulate and improve his level of function. He was motivated to improve his skills every day and had great social support to help him through the difficult times. Another main factor was that he lived on the CLC floor at the Veteran Affairs Hospital and could come down to physical therapy several times throughout the day. After receiving his prosthesis, he was able to progress his wear time, distance of ambulation (using FWW) and stair negotiation and was discharged home a couple weeks later.

There were several limitations in this study, with the most important being lack of functional tests performed. These would have been beneficial to help measure subjective and objective information, and could have been used to measure his progress. I would have had him fill out the Prosthesis Evaluation Questioner (PEQ) to obtain more subjective information about his perception of the prosthesis. The PEQ requires an individual to use a visual analog scale to answer questions regarding prosthesis function,

mobility, psychosocial experience, and well-being.[2, 24] This information may have helped notice areas of concern that would otherwise not be noted.[24] In order to measure more objective data, the Timed Up and Go (TUG) test would have been ideal because it uses several everyday functions. The TUG consists of transitioning from sit to stand, walking three meters, turning around and walking back to sit back down. It is timed from start ("Go" is said) until finish (the patient sits back down). Therefore, it would provide visual feedback for the patient and may help determine areas to improve on. The TUG has been performed on other individuals with a transfemoral amputations and obtained an intrarater reliability of 0.93 and interrater reliability of 0.96 which signifies that it is an accurate level of measurement. In order to measure the validity of the TUG test, it was compared with two functional questioners that include Sickness Impact Profile (SIP68) and Gronigon Acivity Restriction Scale (GARS). The TUG demonstrated a good relationship with SIP68 and a moderate relationship with GARS.[25]

Other limitations of this study include poor documentation of records and lack of detailed information. This includes the amount of time and verbal cues required to complete a task. A more thorough history should have been taken to include questions about how long he smoked and how many packs a day. This may affect his pulmonary system, level of endurance, increase the risk of clotting, and decrease his wound healing time.[26] Sensation tests of his left LE including superficial, deep, and combined sensations should have been performed in order to note any changes. Measurements of the residual limb should have been taken which would help note any changes in the future. The functional tests previously described would also have been beneficial to write goals and

monitor progress. It would have been beneficial to take pictures of his residual limb prior to donning and after doffing his prosthesis in order to note any subtle changes in appearance that might lead to a wound or infection down the road. I could also have recorded him walking using a video camera to show him what he is doing and address areas he can improve, as well as compare the progress he is making. It would have been appropriate to find additional exercises that were functional in order to enhance his skills to perform ADLs.

I would make sure he keeps in touch with the neurologist regarding the decreased sensation in his sound limb and the possible effects this may have on his level of function in the future. A recommendation to a registered dietitian would help him receive adequate nutrition which is critical for his health and endurance.[9] The last recommendation I would make would be for him to find a support group for individuals with amputations.

This individual improved his function during physical therapy but was limited in his ambulatory distance and did not ambulate on uneven terrain on a regular basis.[2] Therefore, the C-leg was not considered in his progression, but it would have been interesting to see how he would have performed using a C-leg. Would the use of a C-leg improve his overall function and endurance the same way it does in younger, more active individuals? In conclusion, it would be beneficial to have more studies related to C-legs compared to other prosthetic knees in older individuals with transfemoral amputations in order to assess the benefits and risks the C-leg provides in these older individual's function.

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