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Pre-Prosthetic Rehabilitation Involving Strength and Positional Tolerance for the Complex Geriatric Amputee: A Case Report

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Abstract

Background: Pre-prosthetic rehabilitation guidelines directing the treatment of geriatric amputees remain under-represented in the literature, especially secondary to other medical and musculoskeletal conditions. Rehabilitation prior to prosthetic prescription most commonly occurs in the inpatient rehabilitation setting. Care involves strengthening of residual limb and sound limbs, balance training, and positional tolerance. **Case Description:** This case report highlights the treatment of a sixty-five-year-old patient who underwent a transmetatarsal amputation followed by a below the knee amputation (BKA) due to poor wound healing. **Evidenced Based Treatment:** Treatment involved integrated strengthening and positional tolerance to develop proximal muscular stability as well as balance training for future prosthetic use. **Outcome Measures:** The primary outcome measure used to assess functional mobility and self-reliance in this case study was the Functional Independence Measure (FIM). The patient demonstrated improvement in all sections of mobility and maintained or improved in all areas related to activities of daily living. **Discussion:** Prior to the prescription of a prosthetic device, physical therapy plays a vital role in preparing the amputee for normal gait mechanics and performance of functional activities. Additionally, the current literature does not address modifications required when musculoskeletal conditions, such as osteoarthritis, impact the patient's care. It is the role of the physical therapist to formulate a plan of care centered around improving quality of life based on patient presentation.

Keywords: Physical Therapy; rehabilitation; pre-prosthetic rehabilitation; amputee; strength; balance; complex; geriatric

Background

Amputation Epidemiology and Trends

Currently 1 in nearly 200 Americans are living with an amputation[1]. According to the National Limb Loss Resource Center of the Amputee Coalition, that equates to approximately 2 million individuals within the United States alone. Vascular disease, trauma and cancer are some of the most common reasons for amputations[1], but differs depending on the age of the patient. For example, trauma related amputations occur primarily in adolescents and adults younger than 45 years old, while 2/3 of the amputations in adults 65 years and older are the result of dysvascular disease[2,3]. Re-amputation of the ipsilateral limb remains an important concern when investigating this dysvascular population and is most commonly seen in foot and ankle amputees, progressing to transtibial or transfemoral amputations[4]. This suggests that higher levels of initial amputations may lead to more successful outcomes when considering foot or ankle amputations.

The field of amputation rehabilitation and prosthetic design has been led by the U.S. Department of Defense and the U.S. Department of Veterans Affairs. These departments have summarized their recommendations in two reports published in 2007[5] and 2017[6]. These clinical guidelines delineate the phases of the amputation rehabilitation into preoperative, acute postoperative, pre-prosthetic, prosthetic training, and long term follow up[5,6]. The guidelines offer a summary of recommendations unique to each phase. However, the clinical detail supporting these interventions is severely lacking. Additionally, little attention is given to the distinct challenges that geriatric amputee patients face. The purpose of this case report is to present the inpatient rehabilitation plan of care for a geriatric amputee based on individualized medical and musculoskeletal factors preceding the fitting of a prosthesis. This clinical shortcoming is made evident in a study which described that only 36% of elderly amputees were successfully fit with a prosthetic[7]. Dade and colleagues noted that re-amputation, cardiovascular disease (CVD), cognitive deficits, skin integrity of both the amputated and contralateral limb, and fixed flexion contracture contribute to unsuccessful fit of prosthetics[7]. Musculoskeletal pathologies, such as low back pain, hip pain, or knee pain, are also common secondary complications significantly impacting mobility and quality of life. The most common musculoskeletal pathology affecting patients with amputations is low back pain (LBP). Low back pain has been linked to poor socket fit and alignment, postural changes, leg-length discrepancy, amputation level, and general deconditioning[8]. Proper physical therapy management in conjunction with a diverse rehabilitation team plays a vital role in helping patients of any age, medical complexity, or amputation level return to leading pain free functional lives.

Case Description

This case describes a 65-year-old adult male who presented to an inpatient rehabilitation unit ten days following a below the knee amputation (BKA). This revised amputation occurred six weeks after a Lisfrance amputation due to wound dehiscence (gaping of a wound, typically following surgery) and suspected osteomyelitis. This case outlines the patient's physical therapy care received during a 12-day stay at a 25-bed inpatient rehabilitation unit attached to a mid-western hospital. This case highlights treatments used for strengthening, positional tolerance, and dynamic balance during the pre-prosthetic training phase. Information from other medical disciplines has been supplemented to provide a comprehensive view of the patient's treatment.

Previous Medical History

Before delving into the patient's inpatient rehabilitation stay, it is necessary to first look retrospectively at the development of the patient's medical complications. The patient presented to his primary care physician (PCP) for consideration of a left hip arthroplasty prior to the initial physical therapy POC. Diagnostic imaging resulted in the incidental findings of heart failure with reduced ejection fraction, and a mass on his left kidney. Cardiac catheterization established two vessel coronary artery disease, with stent placement (left circumflex artery [LCX] and left anterior descending artery [LAD]). Further assessment revealed orthopnea dyspnea with minimal activity and severe lower extremity edema. Therefore, significant past medical history pertinent to this case report included degenerative osteoarthritis of the L hip, coronary artery disease, chronic heart failure with reduced ejection fraction, and acute renal failure.

Initial Amputation – Tarsometatarsal

The patient's initial episode of care began when he presented to the emergency department (ED) with an enlarged blister on his left foot. The wound had been present for approximately 1 month and measured 4.6 cm x 4.5 cm. He reported a similar blister on the dorsal-lateral aspect of the right foot, arising at the same time. When evaluated by physical therapy he was contact guard assistance with ambulation and transfers with use of a single point cane. During subsequent therapy in this episode the patient demonstrated poor tolerance when ambulating short distances. Despite PT's recommendation to remain in the hospital due to safety concerns, the patient was discharged home with scheduled follow up appointments for the wound clinic and cardiology department.

The patient presented to the ED 4 weeks after being he was discharged with increased foot pain. Upon further examination, maggots were found in the wound on his left foot. He was then scheduled for immediate surgical debridement the subsequent day. Following the initial incision and drainage procedure, wounds were stable, yet; edges remained dusky and capillary refill time remained delayed. Six days post-operation, the initial surgical debridement wound examination remained unchanged in both classification and dimensions. As a result, a second surgical debridement and Lisfranc amputation (transmetatarsal amputation, [TMA]) was performed. Post-op Lisfranc amputation examination revealed decreased distal blood prefusion in the form of a faint pedal pulse. The patient was prescribed a boot, placed non-weight bearing precautions and instructed to follow up with podiatry in one week for a wound dressing change.

Occupational therapy evaluation preformed two days following TMA demonstrated modified independence with grooming, dressing, and bed mobility. The patient required supervision with transfers and demonstrated use of adaptive equipment to perform transfers while maintaining weight bearing precautions. Functional mobility was hindered since the patient fatigued when ambulating a distance longer than 10 feet. Occupational therapy assessment revealed that the patient was at baseline for performance of ADLs due to left hip pain. Physical therapy evaluation revealed similar levels of independence. At this point, the patient required a standard walker rather than a cane to ambulate and navigate stairs. This 10-day, acute care episode concluded with the patient discharging home under the supervised care of his sister with podiatry follow up appointments.

Re-Amputation – Below-the-knee

Patient was readmitted one month following Lisfranc amputation, upon suspect of infected foot wound and dehiscence of surgical flap of left TMA (**Figure 1** and **Figure 2**). This integumentary complication remained in the setting of now severe cardiovascular compromise. Additionally, the patient presented with severe wasting malnutrition as a result of progressive weight loss, depression, and type 2 diabetes. The following day, the patient underwent a third irrigation and debridement of the left foot wound.

Figure 1: Patient's left lower extremity. Image taken upon readmittance one-month post TMA, during nursing wound dressing change.

Figure 2: Patient's left lower extremity exposing skin flap. Image taken upon readmittance one-month post TMA, during nursing wound dressing change.

A wound vacuum was applied during the surgical proceedings. He was not seen by rehabilitation therapies during this four-day acute stay. The patient was discharged home three days after his readmission with a wound vacuum. He was scheduled for follow up appointments with the wound clinic to monitor healing progress and change the wound vacuum.

Patient elected to pursue further care at a separate major medical center where he presented with soft tissue swelling and concern for osteomyelitis of the cuneiform. X-ray imaging confirmed the suspicion of bone infection. He underwent a below knee amputation (BKA) two weeks later. Pre-admission data reported that the patient ambulated 1-foot following BKA surgery, required total assistance with bathing, supervision assistance with grooming, and moderate assistance with dressing activities. Additionally, during this episode of care, the patient developed a pressure wound on the coccyx.

Inpatient Rehabilitation Evaluation BKA

He was admitted to the inpatient rehabilitation facility three months after initial wound presentation and seven weeks after initial TMA with the chief complaint of residual limb pain. Upon initial evaluation, the patient demonstrated range of motion (ROM) in bilateral lower extremities within functional limits as well as minimal muscular restriction with left hip and knee extension. Strength was also within functional limits through all myotomes of bilateral lower extremities. Sensation to light touch was intact, with no difference in sensation surrounding the residual limb. Coordination was assessed with alternating toe taps on his intact limb, during which patient demonstrated appropriate function. He performed seated weight shifts and demonstrated protective righting reactions in all planes without upper extremity support. A mobility assessment was performed where the patient required supervision with bed mobility, and minimal assistance with sit to stand and stand to sit transfers. The patient was only able to ambulate 1-2 steps with a front wheeled walker (FWW) before becoming fatigued. He also propelled a wheelchair 150 feet with standby supervision and education regarding proper wheelchair propulsion technique.

Goals/Outcomes:

Patient-centered goals were established to build strength and ambulation capacity to return to golfing in the subsequent summer. Short- and long-term physical therapy goals are outlined below in **Table 1**. FIM baseline measurements along with discharge goals were then established. These measures are displayed in **Table 2**; and represent scores at various time points of the patient's rehabilitation. The FIM has been shown to demonstrate high psychometric consistiency[9]. Research has further validated the FIM use with amputee populations within the inpatient setting[10]. The drawback to the FIM is its insensitivity to specific functional tasks as a generic assessment tool. As a result, we saw that our patient numerically improved on average by only 1 point, below the minimal clinically important difference of 3 points, as outlined by Beninato et al[11]. While this measure triumph's as generic indicator of disability, a major challenge is its ability to parse out nuanced changes in function that are impactful.

Table 1. Patient short- and long-term goals established on admittance to inpatient rehabilitation during initial physical therapy evaluation.

Short Term	
Ambulation	Ambulate at least 20 ft with minimal assistance and least restrictive device.
Bed Mobility	Demonstrate complete independence with all bed mobility tasks.
Transfers	Demonstrate modified independence with all transfers.
Wheelchair Management	Demonstrate ability to manage wheelchair on both even and uneven surfaces distances greater than 200 ft.
Balance	Demonstrate ability to balance on uneven surfaces for greater than 15 seconds with one upper extremity support and minimal assistance.
Long Term	
Ambulation	Ambulate at least 25 ft with modified independence and least restrictive device.
Home Exercise Program	Demonstrate complete independence with home exercise program consisting of strengthening and stretching exercises to facilitate prosthetic fitting.
Balance	Demonstrate ability to balance on uneven surfaces for greater than 30 seconds with one upper extremity support and supervision assistance.
Wheelchair Management	Demonstrate ability to manage wheelchair on both even and uneven surfaces distances greater than 300 ft.
Stairs	Demonstrate ability to perform four steps with bilateral upper extremity support and supervision assistance to promote safe discharge home.

Table 2. Patient FIM outcomes measures at evaluation, discharge goal, and upon discharge from facility. Established upon admittance to inpatient rehabilitation during initial physical therapy evaluation.

FIM Measure	**Evaluation**	**Goal**	**Discharge**
Walk	1 – Total Assistance	1 – Total Assistance	2 – Maximal Assistance
Wheelchair	5 – Supervision Assistance	6 – Modified Independence	6 – Modified Independence
Bed, Chair, Wheelchair Transfer	4 – Minimal Contact	6 – Modified Independence	4 – Minimal Contact Assistance
Stairs	Not Assessed, Patient Safety	2- Maximal Assistance	1 – Total Assistance
Bathing	Not Assessed	6 – Modified Independence	6 – Modified Independence
Eating	7 – Complete Independence	7 – Complete Independence	7 – Complete Independence
Grooming	Not Assessed	6 – Modified Independence	6 – Modified Independence
Lower Body Dressing	Not Assessed	6 – Modified Independence	6 – Modified Independence

Upper Extremity Dressing	Not Assessed	7 – Complete Independence	7 – Complete Independence
Toilet Transfer	2- Maximal Assistance	6 – Modified Independence	6 – Modified Independence
Toileting	1 – Total Assistance	6 – Modified Independence	6 – Modified Independence
Tub, Shower Transfer	Not Assessed	6 – Modified Independence	6 – Modified Independence
Bladder Management	5 – Supervision Assistance	6 – Modified Independence	6 – Modified Independence
Bowel Management	5 – Supervision Assistance	6 – Modified Independence	6 – Modified Independence

Evidence-Based Treatment

There is little evidence directly investigating the targeted interventions for the below knee amputee in the fields of strength, positional tolerance, and balance. Though there are general guidelines, high quality intervention specific research is lacking.

The ultimate purpose for lower extremity strengthening of the residual limb and proximal musculature of the amputated limb is to develop adequate control of the prosthetic limb. It is also important to note that upper extremity strengthening should not be neglected, as arm strength directly impacts transfers, ambulation utilizing an assistive device, and wheelchair mobility. Trunk stability also plays an important role during ambulation with a prosthesis. Eisert and Tester first described a series of dynamic strengthening exercises for the residual limb[12]. Their work has since been adapted by numerous institutions and organizations. These exercises include: prone hip extension, side-lying hip abduction (closed kinetic chain of residual limb), prone hip flexion, prone back extension, side-lying hip adduction, single leg bridging, sit ups, knee extension, and knee flexion. The majority of these exercises were closed chain in nature. While the patient's rehabilitation did not strive to duplicate these exercises, strengthening was employed in a similar fashion with positional variations. According to the recommendations set forth by the Department of Veterans Affairs, specific muscle groups to strengthen to improve prosthetic performance include the hip extensors, hip abductors, hip adductors, trunk musculature, knee extensors, rotator cuff, and elbow extensors[5]. While strength training during all phases of post-amputee rehabilitation is instrumental to improved outcomes, research is limited on specific interventions during the pre-prosthetic training phase.

Although strength training has an impact on future outcomes with prosthetic use, balance training has associations toward both future prosthetic training as well as immediate safety implications. In a study by Hendershot and Nussbaum, lower limb amputees demonstrated increased center of pressure displacement with seated balance, suggesting a link between limb loss and trunk postural control[13]. They hypothesized that reductions in postural control and core stability are the result of adaptations in neuromuscular responses and changes in tissue properties caused by repetitive exposure to abnormal gait mechanics. This observation holds implications for both balance and core stabilization training. In addition to lacking intervention-specific analysis, general balance recommendations remain in conflict. The 2007 clinical practice guidelines for lower extremity amputees outlines that balance interventions should start with sitting balance, progressing to sitting weight shifts, then sit to stand, supported standing, single limb balance, and ultimately dynamic balance training. However, in the most recent 2017 review, these recommendations for lower extremity amputees were selectively deleted from the clinical practice guidelines. The same fate held true for the recommendation that balance should be challenged with a variety of activities such as weight shifting on an unstable surface, rocker board, ball rolling to sound foot, and step ups. Many of these balance modalities were employed in the later phases of rehabilitation in the patient described in this case report.

Development of positional tolerance has implications for the progression of an amputee's independent functional capacity. Most significant motives include prevention of hip and knee flexion contractors, prevention of phantom limb sensations, and comfort. Early in the pre-posthetic timeline, the risk of developing a hip external rotation contracture increases while bedbound. This risk is reduced with the use of a trochanteric roll[14]. Prevention of these contractures is instrumental in the inpatient setting as they eventually interfere with proper prosthetic fit, negatively impact energy expenditure, and adversely affect gait mechanics[15]. Interventions should address frequent position changes, time spent lying prone, and a daily range-of-motion program[16]. While a prone lying protocol is not always required in the transtibial amputee, it should be encouraged[17]. In this population, soft mattresses, laying in a semi reclined position, and prolonged sitting are often the culprit of developing contractures. The cause of contractures is due to improper positioning in bed or when seated in a wheelchair[18]. To combat this, therapists should encourage periods of lying prone or supine to implement a low load stretch on the hip flexors. Knee immobilizers are often used to position the residual limb in full knee extension[19]. When positioned in a wheelchair, leg attachments should be used to maintain the knee at zero degrees of extension, therefore preventing the limb from falling into a dependent, flexed position[18]. Lastly, early ambulation assists in maintaining hip joint ROM[14].

Table 3. Strength, Position, and Balance Interventions Used for Each Treatment Session

Day	Strength	Position	Balance
Initial Exam	Lower extremity strength tested as within functional limits bilaterally. Isolated testing on left hip flexion was 5/5	Tolerates side-lying position briefly (less than 1 min). Prone position change not attempted.	Patient able to sit edge of bed without upper extremity support. Patient able to stand with bilateral upper extremity support. Patient able to stand with 1 upper extremity support for less than 10 seconds. Ambulation 15 feet with FWW assistance.
Day 1	Supine strengthening consisting of bilateral quad sets, glute sets, straight leg raises, hip abduction, hip adduction. Right lower extremity: short arc quads, heel slides. Right side-lying strengthening: left lower extremity hip extension, hip abduction, and knee flexion	Static standing bouts, 2 min x 2 (CGAx1) Sit to stand and stand pivot transfers to wheelchair (ModAx1)	Ambulation 20 feet x3 with FWW assistance.
Day 2	Supine strengthening. **See Previous.** Addition of knee flexion with over pressure, isometric, and TheraBand resistance modalities.	Stand pivot transfers to wheelchair (CGAx1).	Ambulation 25 feet x4 with FWW assistance.
Day 3	Supine strengthening. **See Previous.**		Ambulation 25 feet x4 with FWW assistance.
Day 4	Supine strengthening. **See Previous.** Addition of NuStep, workload 4, 5 min, bilateral arms and R leg.	Sit to stand transfer, 3 repetitions (MinAx1). Right side-lying hip flexor stretch 2x60 seconds	Ambulation 40 feet x4with FWW assistance.

	Seated strengthening consisting of bilateral glute sets and marching. Right lower extremity: long arch quads and knee flexion, right hip abduction, hip adduction, hip flexion (RTB)		
Day 5	Supine Strengthening. **See Previous.** Right side-lying. Left hip flexion, hip extension, hip abduction. NuStep duration progressed to 7 min (WL 4).	Stand pivot transfers to wheelchair (CGAx1). Right side-lying hip extension stretch 3 x 1min. Prone bilateral knee flexion. Supported standing. Left hip flexion	Ambulation 60 feet x3 with FWW assistance. Dynamic bilateral upper extremity manipulation (balloon batting) with support of walker (MinAx1)
Day 6	Supine Strengthening. **See Previous.** NuStep duration progressed to 12 min (WL 4).	Prone bilateral knee flexion. Prone on elbows 3x30 seconds. Supported standing. Left hip flexion	Ambulation 80 feet x4 with FWW assistance. Dynamic bilateral upper extremity manipulation (balloon batting) with support of walker (MinAx1)
Day 7	Seated strengthening. **See Previous.** Increased Resistance to 2# or GTB.	Supported standing left hip flexion, hip abduction, and hip adduction.	Ambulation 80 feet x4 with FWW assistance.
Day 8	Seated strengthening. **See Previous.** Supine Strengthening. **See Previous**	Right side-lying hip extension stretch 5 x 1min. Prone on elbows 4 x 1 min.	Ambulation 90 feet x4 with FWW assistance. Dynamic bilateral upper extremity manipulation (balloon batting) with support of walker (MinAx1)
Day 9	Seated strengthening. **See Previous.** Front facing Kinotron, 10 min, 50 cm/sec right lower extremity.	Edge of mat left hip extension stretch 3 x 1 min	Ambulation 100 feet x4 with FWW assistance. Static standing on airex foam. 1 round 3 min. 1 round 5 min. walker support
Day 10	Seated strengthening. **See Previous.** Supine Strengthening. **See Previous.**		Ambulation 125 feet x4 with FWW assistance. Dynamic bilateral upper extremity manipulation (balloon batting) with support of walker (MinAx1). 2 rounds preformed. Reaching across body.
Day 11	Seated strengthening. **See Previous.** Supine Strengthening. **See Previous.** Backward hop	Right side-lying hip flexor stretch 3 x 60 seconds	Ambulation 100 feet x2, 150 feet x1 with FWW assistance.

	from walker up two steps to wheelchair x 4 repetitions preformed.		Dynamic bilateral upper extremity manipulation (balloon batting) with support of walker (CGAx1). 2 rounds preformed.
Day 12	**Day of Discharge**		

Discussion

Medical and musculoskeletal complexity

This patient presented with numerous musculoskeletal and medical comorbidities both initially and acquired as his overall course of medical care proceeded. While in isolation, these comorbidities are not uncommon to see in the post-amputation patient; however, the volume of co-morbidities greatly complicated the care of this patient. The patient in this case report presented with impairments to the cardiovascular, digestive, integumentary, muscular, renal, and skeletal systems all which required medical intervention before rehabilitation could be initiated and concurrently once rehabilitation began. Thus, frequently interrupting our physical therapy plan of care with respect to desired intensity of interventions. According to Kurichi et al, patients with peripheral vascular disease, systemic sepsis, renal failure, congestive heart failure, psychoses, metastatic cancer, paralysis, or other neurological disorders are less likely to receive a prosthetic prescription[20]. Future investigations should be employed to assess effective medical and therapeutic interventions for patients with more than one significant complicated medical factor. This consideration of medical and functional impairments is instrumental during pre-prosthetic rehabilitation, as these impairments adversely affect level of energy and ability to move independently. Medical and musculoskeletal conditions have been shown to reduce the likelihood of prosthetic prescription[20].

Throughout the subject's rehabilitation hip pain remained a limiting factor, recall that his initial presentation was based on his consultation for a left hip arthroplasty. During treatments he would note that the positions were uncomfortable, not due to the residual limb, but rather the discomfort in his left hip. This led to an orthopedic investigation, revealing that most orthopedic research done in patients with lower extremity amputation involves the impact of low back pain during post prosthetic gait training. Abdul-Statter and Smith et al report that often lower limb amputees identify low back pain as more bothersome than residual limb pain[21,22]. Their findings are consistent to the subjective complaints of those observed in our patient. However, the patient in this case report expressed discomfort in his contralateral hip rather than low back. The prevalence of low back pain in this cohort is between 50 and 90%[23]. With that elevated degree of incidence, the author reports that there is a direct translation to other areas of the body such as the hip. The quandary this presents is the management of both the amputation and the hip pain. While there are, in essence, two separate generators of dysfunction, their interaction on the patient's functional outcomes cannot be untangled.

Osteoarthritis (OA) remains the most common cause of disability among adults with an estimated 27 million people suffering from the degeneration of joint cartilage[24]. With this prevalence in the general population it goes without translation that compounding an amputee's care with this condition would only complicate their rehabilitation. Research demonstrates that the rate of OA was 65% higher in amputees than non-amputees. Below knee amputees present a 10 to 15 times higher rate of knee OA than their non-amputee counter parts[8]. Radiographic investigations present evidence of increased OA in the intact hip (16.7%) compared with the amputated side[25]. Mussman et al. reported that nearly a quarter of veterans with amputations experienced contralateral hip pain[26]. This incidence is 10% higher when stratified by amputation level. The prevalence of hip pain among veterans with transtibial and transfemoral amputations was 29% and 19%, respectfully. Amputation rehabilitation places a strong reliance on the sound limb and need to maintain mobility. Thus, the primary goal of an amputee with diagnosed OA must include methods for protecting the sound limb joints from further degeneration.

Therefore, with regard to the patient in this case report, it was important to address the pain he was experiencing in his right hip although it was not directly related to his amputated limb.

Challenges presented with Geriatrics

There are numerous challenges to addressing complex medical procedures in any patient population and geriatric amputees are no exception. The median survival rate in geriatric amputees is 1.5 years after an amputation, while the expected survival rate is 7.5 years for age-matched controls[27]. There is a significant increase in 30-day mortality rate related to age and number of co-morbidities[28]. If a geriatric patient presents with four to five co-morbidities, they are seven times more likely to die within 30 days of their amputation procedure as compared to patients with only one co-morbidity[27]. The management of this population relies on the therapist's ability to monitor the patient's progress and treatment tolerance. This is achieved by making decisions on clinical and physiologic factors rather than assuming the patient cannot perform an activity or exercise solely because of their age or disease process. Towards that aim, there are some influential facts to consider when rehabilitating this special population.

Orthostatic hypotension, ROM, and mobility should remain the concerns at the forefront of a therapist's plan of care when working with a geriatric patient. Orthostatic hypotension is the result of age-related decline in the baroreflex function that results in an inadequate rise in heart rate and subsequent reduction in cardiac output during positional changes[29]. It produces potential negative effects on the immediate post-operative interventions. Combating this condition should be achieved by monitoring blood pressure and heart rate during interventions. Decline in ROM is a naturally observed consequence of aging which is exacerbated in the geriatric amputee where decreased hip extension ROM is commonly observed. The final consideration, mobility, serves a dual purpose; prevention of falls should remain an important goal. Due to decreased stability of the lower extremity in amputees, increased attention needs to be placed on pre-gait interventions such a standing, sit to stand to an assistive device, and single limb balance—all of which train the amputee to develop toward the functional demand of walking and improved ambulation stability. Additionally, early mobility must be implemented in order to prevent further complications. Due to the age-associated physiologic changes and prevalence of systemic co-morbidities, geriatric patients are at a higher risk of post-operative complications including pneumonia, urinary tract infections, local and systemic infections, cardiac complications, prolonged ileus, and deep-vein thrombosis[30]. All of these considerations further highlight the importance of regaining functional mobility with a prosthetic device following an amputation.

While advanced age may influence potential gait retraining success[31], an important tenant of amputee rehabilitation remains that advanced age alone is not a contradiction to prosthetic limb prescription. Factors influencing prosthetic fit include those already discussed, such as medical comorbidities. Additional factors closely associated with the geriatric population include premorbid function, level of amputation, status of the remaining limb and patient motivation[31]. All amputees will benefit from a rehabilitation program to increase independence in transfers and learn wheelchair skills[31]. While advanced age complicates rehabilitation because of medical complexity and increased post-surgical mortality if physical therapists consider cardiovascular implications, ROM deficits, mobility goals and the patient is motivated, successful prosthetic limb use in this population is possible and contributes greatly to the patient's quality of life.

Summary

This case provides an example of the many complications that can occur prior to and following a limb amputation. The pre-rehabilitation interventions of strengthening, positional tolerance, and dynamic balance prepare these patients for fitting of a prosthesis and ultimately leads to an improved quality of life. Ensuring that interventions are tailor fit to patients, regardless of medical and musculoskeletal factors allows rehabilitation therapies to maximize their effectiveness in facilitating patients' return to independent, functional lives.

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