The Psychological and Physical Rehabilitation of Amputees

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Abstract

Since physical therapy requires constant interaction with other people, it is a career that requires not only medical knowledge, but knowledge of the human psychology as well. A physical therapist may be well versed in recovery techniques, but how will he or she get the patient motivated if the patient is not motivated to begin with? Every person is different. Rehabilitation of amputees is a delicate process that requires significant work over an extended time period. Many factors are involved during the preoperative phase, as well as the postoperative phase. However, by being aware of the patient's mental status and providing adequate patient education, the physical therapist and health care team can provide an extremely effective rehabilitation program. By understanding the patient and prescribing the proper exercise program, a physical therapist can help an amputee reach a high level of functionality.

The Psychological and Physical Rehabilitation of Amputees

Many people incur an illness or experience an accident that results in the loss of a limb. They may also have been born with a congenital condition in which one or more of their limbs are missing. Thirty years ago, approximately 400,000 people were living with an amputation in the United States. Also, approximately an additional 50,000 amputations were performed each year. About 90 percent entailed the lower limb. Diabetes mellitus and peripheral vascular disease accounted for roughly two-thirds of all lower limb amputations (Bradway, Malone, Racy, Leal, & Poole, 1984).

Now, approximately 2 million people are living with an amputation in the United States, with nearly an additional 185,000 amputations being done each year. Vascular disease accounts for more than half of limb amputations (54%). This includes diabetes and peripheral arterial disease. Forty-five percent of amputations are due to trauma. Cancer accounts for less than 2% (“Limb loss,” 2016).

While an amputation may be a somewhat welcomed relief from chronic pain or infection, the disability that accompanies it, however, is not welcomed (Bradway, et al., 1984). Although lower limb amputations are more common, the loss of an arm, whether partial or complete, presents a momentous psychological and physical injury to the amputee (O’Keeffe, 2011). Due to the rising number of amputations that are taking place, especially in the elderly population, it is pertinent that further studies be done concerning the psychological adaptation and rehabilitation of patients. Because of the wide variety of scenarios that take place involving amputations, the psychological reactions exhibited by patients are diverse and multifaceted. However, the adaptation process can be split into a preoperative stage and three subsequent postoperative stages. Certain emotions and defense mechanisms have been identified for each of the four stages (Bradway et al., 1984).

When a person undergoes an amputation, the journey that lies ahead is a long one. The patient must go through a long healing process, both physically and emotionally. It is vital that the person be surrounded by an excellent support group consisting of family and friends. The physician, therapist, prosthetist, and psychologist working with the patient must also form a close network and maintain excellent communication.

Causes of Amputation

Many events, diseases, and conditions may result in the loss of a limb. In the United States, the most common cause of amputation is diabetes. Additionally, every year, at least 15,000 people lose feet or legs due to land mines in past war zones (DeMello, 2009). The wars in Iraq and Afghanistan also contribute the vast number of people who have lost limbs; soldiers, as well as civilians, have lost legs and feet due to the war. Finally, congenital conditions, diseases, industrial accidents, and car accidents are among the other causes of lost limbs.

Diabetics make up slightly over half of all amputations done in the United States each year. The other half of amputations are due to trauma, infection, or tumors. About 6,000 to 10,000 of the amputations performed are done on the upper extremity. The most common causes for upper limb prostheses are trauma, osteosarcoma (tumor), dysmelia (deformity), phocomelia (shortened limb), and amelia (absence of the upper limb) (“Amputation and limb,” n.d.).

History and Development of Prostheses

Bryant (2014) notes some of the earliest uses of prosthetic limbs. The first written record of an artificial leg was made by the Greek historian Herodotus; this record was a documented story of a prisoner who escaped by amputating his foot. The prisoner found and used a wooden limb to assist him in walking. In a later discovery, researchers found a prosthetic device in Egypt which was used to replace a big toe; this prosthesis was made out of leather and carved wood. Researchers believe that it is approximately 3000 years old. An artificial leg, made of wood and copper, was found in Italy in 1858, and it is believed to be from around 300 B.C.

In the primitive era of prosthetic limbs, wooden or iron rods were attached to the stump of the leg. Straps were usually used to keep the rod in place. During the Middle Ages, peg legs and hook arms were available for amputees to use. During the age of the Renaissance, prosthetic device construction improved, and prostheses were beginning to be made out of materials such as iron, copper, steel, and wood (Demello, 2009). Ambroise Paré, a surgeon who lived in France during the sixteenth century, was dedicated to treating injured soldiers who had lost limbs in battle (Bryant, 2014). Paré also created new methods of amputation. Instead of cauterizing arteries, which was the common practice at the time, he suggested tying off the arteries. Additionally, he developed the first mechanical hand, as well as the first artificial leg with locking knees. At this time in history, materials such as leather were being used in the construction of prosthetic limbs in order to make them lighter. During the seventeenth century, a Dutch surgeon by the name of Pieter Verduyn invented the first non-locking, below-knee prosthesis (DeMello, 2009).

Prosthetic limbs have greatly improved since the time of Paré and Verduyn. In 1800 a man named James Potts constructed an artificial leg that was made out of wood and included artificial tendons that were made from cat guts. This prosthesis and its artificial tendons permitted movement of the foot. In 1812, an artificial arm, which was attached to the opposite shoulder by means of straps, allowed the wearer to move the artificial appendage with his shoulder movements (Demello, 2009). In 1863, the rubber hand was invented; it was significantly more realistic than the models preceding it (Bryant, 2014). Prosthetic limb technology improved during the Civil War because of the number of soldiers who had lost appendages. The creation of anesthesia in the 1840s allowed for amputation surgeries to last longer. Anesthesia increased the rate of survival for patients. Doctors did not have to spend as much time and energy keeping the patient's body under control; surgeons could operate more thoughtfully. Also during this decade, James Syme created a method for amputation. Instead of amputating at the thigh, amputation was done at the ankle, thereby allowing more people to keep their legs. In 1898, an artificial arm was created by an Italian named Vanghetti. This arm could be controlled via movements of the muscles (DeMello, 2009). Once again, prosthetic technology began to advance after World War I and World War II due to the increase in amputees. A special sock, which improved comfort and stability, was invented for above-knee prosthesis. In the years that followed, better materials were synthesized to construct prosthetics. Carbon fiber was a stronger and more lightweight material. Also, silicone was used to produce realistic-looking skin (Bryant, 2014).

The first hook that could open and close and that was operated by flexing muscles in the opposite shoulder was invented in 1909 by D. W. Dorrance. After World War II, the Artificial Limb Program began to do research regarding prosthetic limbs and to develop prostheses. The Veterans Administration offered grants to private corporations to make new prostheses. As a result, the older wooden and leather models were replaced by new prostheses. New methods for attachment and fitting were also developed (DeMello, 2009).

Technology has progressed, and there are now bionic prostheses. In simplest terms, the prosthesis contains sensors that send signals to the brain, and, in the case of an upper limb prosthesis, the user is able to activate individual fingers and work through a full range of motion. Some patients will undergo a surgical procedure called re-innervation. This procedure uses sensors that are implanted in the patient’s shoulders, pectoral muscles, and residual limbs. There are also other methods that do not require invasive surgery (Barrie, 2014).

Materials for Prostheses

In the 1900s, prostheses started to look and feel more realistic because they were beginning to be made from materials such as plastic, silicone, and PVC. These materials allowed them to be stronger and lighter. Today, most prostheses are made out of plastic that encases the interior structure, and they are attached by straps and sock. This sock cushions and protects the stump. If the socket is not fixed by straps, it is fixed via suction to the stump. Most prosthetic feet are made with wood; however, they now consist of also foam and plastic (DeMello, 2009).

The most commonly used materials in current prosthetic devices are leather, metal, wood, thermoplastic and thermosetting materials, foamed plastics, and viscoelastic polymers. Five characteristics are considered when deciding what materials to use to construct a prosthesis: strength, stiffness, durability, density, and corrosion resistance. Strength, which is determined by the amount of weight that the material can withstand, is important in lower appendage prostheses. Stiffness is the amount of bending that is allowed when the material is loaded. For example, a stiffer material is desired for a rigid prosthetic frame, but a more flexible material is desired for a flexible transfemoral prosthetic socket. Durability, or fatigue resistance, is determined by the material's ability to withstand repeated loading and unloading. Density, the weight per unit of volume, is important because it is a determinant of energy cost while a person is wearing the prosthesis. If a material is susceptible to corrosion, it is vulnerable to be damaged by chemicals. Prosthetic limbs are often made from materials that preserve heat, thereby creating the problem of perspiration; it is better to make prostheses out of materials which are resistant to moisture. Prostheses that are made of materials that are resistant to moisture are more readily cleaned than porous substances (Lusardi, et al., 2013).

Further Developments

Although it was not available for public use until the 1960s, the first biomechanical prosthesis, which used myoelectricity, was created in the 1940s. The product continued to be tested and perfected before being sold. Prostheses such as these are connected to the body in a manner that permits electrical impulses to go from the muscles into the prosthesis, causing movement in the prosthesis. Additionally, the nerves in the appendage are surgically adapted to direct movement in a muscle that has been attached with biosensors. Biosensors sense movement that occurs in a muscle and convey it to a controller that is located in the prosthesis. A flexed muscle, therefore, causes the prosthetic to move (DeMello, 2009).

A new way now exists to attach prostheses to the body; a titanium bolt is screwed into the bone of the stump. The bolt gets attached to an abutment, or support, that is then attached to the prosthesis. This method reduces pain for the patient since it reduces the pressure on the stump; following this practice also permits greater control of the prosthesis by muscles. Once a doctor prescribes a prosthesis to a patient, a prosthetist then custom-fits an artificial limb for the patient. It is much more difficult for people who have lost their leg above the knee to walk and do other activities, as opposed to those who have only lost a foot or the lower leg. Therefore, physical therapy is necessary for the patient to be taught how to utilize the prosthetic limb. It usually takes a number of weeks for a patient to acquire the skills needed to walk, drive, and do other daily activities (DeMello, 2009).

Athletes who are missing legs now have access to special apparatuses that can help them run. Known as Cheetah blades, these devices are made out of carbon fiber and formed like sickles. They do not imitate the look or feel or real lower limbs; rather, they are made to permit running. Much controversy has risen over this technology as to whether or not it gives disabled athletes an advantage over other “normal” athletes. Additionally, they are unaffordable for many people (DeMello, 2009).

Every year, prosthetic technology improves. For example, next generation prosthetic knees feature motors which dynamically raise and excite the patient’s muscles in order to participate in activities such as walking up stairs and ramps. “Artificial intelligence” qualities allow systems to predict and direct movement (Lusardi, et al., 2013). Researchers are also working on prosthetic limbs that can be operated by the brain.

Types of Prostheses

A transtibial prosthesis replaces the lower leg and foot; a transfemoral prosthesis replaces the entire leg and foot. A transradial prosthesis replaces a missing lower arm and hand; a transhumeral prosthesis replaces the entire arm and hand. There are specific needs that lower limb and upper limb prostheses need to meet. Although prosthetic legs and feet may be less complicated since they do not need to grip and handle objects such as upper limb prostheses. They do, however, need to sustain the weight of the body and provide for locomotion (DeMello, 2009).

Four basic levels of prosthetic feet are made: K1, K2, K3, and K4. Persons at the K1 level possess limited functionality; they have the potential to use a prosthesis on level surfaces. Persons at the K2 level have the capacity to walk around at home and in the community at a slow speed. If a patient is able to participate in all daily activities and to walk at a varying tempo, they are classified with K3 feet. K4 feet are for serious athletes and weekend runners (Lusardi, et al., 2013).

Transtibial prostheses are composed of a socket design, shin-socket interface, suspension strategy, and additional modular components, such as, feet, shock absorbers, torque absorbers, and dynamic pylons. Patellar tendon-bearing socket and total surface-bearing socket are two socket designs. Hard sockets, socks and sheaths, soft inserts, flexible inner sockets, expandable wall sockets, and gel liners are interface materials. Waist belts, joints and corsets, cuff straps, supracondylar suspensions, supracondylar/suprapatellar sockets, sleeves, suction, locking liners, semirigid locking liners, and elevated vacuum are suspension techniques (Lusardi, et al., 2013).

Four main socket designs are made for transfemoral prostheses: quadrilateral, ischial-ramal containment (IRC), Marlo Anatomical Socket (MAS), and subischial (elevated vacuum) socket. Many transfemoral suspension systems exist: traditional pullin suction suspension, roll-on suspension liners, shuttle lock systems, lanyard system, cushion liner with air expulsion valve, elevated vacuum, Silesian belt suspension, total elastic suspension belt, and pelvic belt and hip joint. The prosthetist and patient can also choose from a variety of prosthetic knee units: single-axis, polycentric, manual locking, hydraulic, and pneumatic knee units (Lusardi, et al., 2013).

Lusardi, Jorge, and Nielson (2013) explain the wonder of microprocessor technology for knee units:

> Microprocessor knees are typically equipped with sensors that monitor the knee position during swing; they are also equipped with pressure sensors detecting and evaluating ground related forces during stance. Sensor technology is capable of measuring angels, moments, and pressures at the rate of 50 times per second. Customized adjustments are commonly made to microprocessor knees using a laptop or handheld computer. Unique software algorithms determine the phase of gait, then immediately adjust the knee functions to compensate during both the stance and swing phases of gait. Most knee mechanisms provide a stumble recovery feature that limits unintentional bending of the knee that sometimes occurs when walking on uneven terrain. (p. 665)

Conventional (body-powered) systems consist of any prosthesis that uses a control cable system to translate volitional muscle force and shoulder or arm movement in order to operate a prosthetic elbow (Lusardi, et al., 2013, p. 800). Externally powered systems consist of an electric power cell that provides electrical current to prosthetic components (Lusardi, et al., 2013, p. 805). Hybrid prostheses that combine conventional and externally powered systems may be the best solution for some individuals (Lusardi, et al., 2013, p. 809).

Prosthetic Limb Construction

The process of constructing a prosthesis typically consists of six steps:

1. Taking accurate measurements of the limb
2. Making a negative impression (cast)
3. Creating a three-dimensional positive model of the limb or body segment
4. Modifying the positive model to incorporate the desired controls
5. Fabricating the prosthetic socket around the positive model
6. Fitting of the device to the patient. (Lusardi, el al., 2013, p. 152)

It is important that the prosthesis be properly constructed, for the following factors affect energy expenditure: weight of the prosthesis, quality of the socket fit, accuracy of alignment of the prosthesis, and functional characteristics of the prosthetic components (Lusardi, el al., 2013, p. 653).

Amputation Rehabilitation

The level of rehabilitation success after amputation is influenced by factors such as age, health, cognitive status, sequence of the onset of the disability, concurrent diseases, and the level of the amputation. The preprosthetic phase consists of managing the part of the limb that remains, and this includes tasks such as caring for the wound, controlling edema, shaping, desensitizing, and increasing joint and muscle flexibility. Besides strengthening the extremities for use of the prosthesis, it is also extremely important to strengthen the trunk, or core. Physical therapists are responsible for deciding whether a patient is ready for prosthetic fitting, coordinating prosthetic training, and consulting with prosthetists if issues with alignment result (Lusardi, et al., 2013).

When a person undergoes an amputation, many people are included in the rehabilitation process. Individuals who are part of this health care team involve people such as physicians, nurses, prosthetists, orthotists, physical therapists, occupational therapists, dietitians, and vocational rehabilitation counselors. One of the main topics that this team should be concerned with is patient education. By providing information about the health condition, treatment, management, and prognosis, the patient can become an active participant in the rehabilitation process, rather than passively receiving care (Lusardi, Jorge, & Neilsen, 2013).

Besides the obvious deficiency of bodily function, amputees may also suffer from psychological, emotional, cognitive, and other physical complications. Amputation includes the loss of function, sensation, and body image (Racy, 1992). Not all people suffer from diseases, such as diabetes, before experiencing an amputation. Unfortunately, some are young and healthy before a traumatic event occurs which requires the amputation. Fortunately, artificial limbs can enable these people to return to their activities of daily living and to still be able to do things such as run, walk, reach, and grip. These apparatuses are known as prostheses.

When working with amputees, the physical therapist and the prosthetist form a close relationship with their patients. Prosthetists are health care professionals who have been trained to evaluate and to care for the bodily and operative limitations that are a result of sickness or disability, such as an amputation. Prosthetists have been educated in how to recommend, choose, create, install, and monitor prostheses (“What is,” 2016).

The role of the prosthetist is to construct and adjust the particular socket design that is needed by the patient. The components of a prosthetic limb also depend on the patient's lifestyle. Physical therapists are health care professionals who help patients reduce pain and enhance mobility. Physical therapists teach patients how to handle and control their condition. Patients are evaluated, and a plan and treatment techniques are developed in order to promote mobility and function, reduce pain, prevent any further loss of mobility, and prevent disability ("Who are," 2015). The job of the physical therapist is composed of three main components. First, before the patient is even fitted for the prosthetic limb, he or she must be educated on how to care for the residual limb, and they must also be physically prepared for prosthetic gait training. Next, the patient must learn how to use and take care of the prosthesis. Third, the physical therapist should present higher levels of activity that are safe for the patient (Gailey & Clark, 1992).

Evaluation, patient education, pre-prosthetic exercise, pre-gait training, gait training skills, and advanced gait training activities are all part of the post-surgical management. The evaluation consists of documentation of past medical history, mental status, range of motion, strength, sensation, bed mobility, balance, coordination, transfers, wheelchair propulsion, ambulation with assistive devices without a prosthesis, and cardiac precautions. Limb care, problem detection, skin care, prosthetic management, sock regulation, donning and doffing of the prosthesis, and residual limb wrapping comprise patient education of limb management. Strengthening, range of motion, functional activities, general conditioning, bed mobility, transfers, unsupported standing balance, and ambulation with assistive devices are the main components of pre-prosthetic exercises. Balance, coordination, center of gravity and base of support orientation, and single-limb standing are important things to focus on during pre-gait training. Sound limb training, prosthetic limb training, and pelvic motions are skills that are worked on during gait training. The following are advanced gait training activities: stairs (step by step and step over step), crutches, curbs, uneven surfaces, ramps, hills, sidestepping, backward walking, multidirectional turns, tandem walking, braiding, single limb squatting, falling (lowering the body to the ground), floor to standing, running skills, and recreational activities (Gailey & Clark, 1992).

Phantom limb sensations and phantom pain are special areas of concern. Many amputees still have the feeling that the amputated limb is present and moving; however, very few people experience phantom limb sensations after a year when the surgery took place. Also, phantom limb sensations do not pose any type of risk or hazard. Phantom pain (pain experienced in the missing limb) is a much more serious matter; although, it is relatively rare (Racy, 1992).

Mirror Therapy has been shown to alleviate phantom limb pain. A study by Chan et al. (2007) was completed with eighteen subjects. Patients completed their appointed therapy for fifteen minutes every day. After four weeks, it was revealed that pain intensity and the length of pain episodes declined with mirror therapy. Chan and her colleagues explain:

> Pain relief associated with mirror therapy may be due to the activation of mirror neurons in the hemisphere of the brain that is contralateral to the amputated limb. These neurons fire when a person either performs an action or observes another person performing an action. Alternatively, visual input of what appears to be

movement of the amputated limb might reduce the activity of systems that perceive protopathic pain.

The Psychological Effects of Amputations

Rehabilitation of an amputee is a two-fold process—physical and psychological. Not only are function and sensation lost, but body image is often muddled as well. What is the cause of many amputees being able to adapt? It is due to the spirit, strength, and toughness of the patients, as well as the skill and devotion of their health care providers (Racy, 1992).

Several psychosocial and health variables may determine the psychological response of an amputee. These variables may also reflect the health and the medical and surgical management of the amputee. Age, personality type, economic and vocational variables, and psychosocial support are psychosocial variables; narcissistic, depressive, timid, pessimistic, and self-conscious are examples of different personality types. Health, reason for amputation, preparation for the amputation, surgical complications, prosthetic rehabilitation, the team approach, and vocational rehabilitation are medical variables. These psychosocial and medical variables are determinants of the observed psychological response (Racy, 1992).

Adaptation includes several stages. Initially, amputees often experience many emotions—depression, anxiety, resentment, anger, embarrassment, fear, and helplessness. First is the preoperative stage. Although there is usually a degree of anxiety or concern, generally, the more time the patients have to prepare for the procedure, the better they accept the process. Concerns usually fall into one of two groups—practical issues and symbolic concerns. Practical issues include the loss of function, pain, difficulty adapting to a prosthesis, cost of treatment, and loss of income. Symbolic concerns include changes in appearance, perception by others, and losses in sexual intimacy (Racy, 1992). The patient’s response is also affected by the way the surgeon presents the operation. Clear and effective communication by the surgeon, as well as the entire health care team, is imperative. Next is the immediate postoperative stage. The time between the end of the surgery and the start of rehabilitation may vary from hours to days. Many individuals are emotionally “numb” during this stage; if they went through a great deal of suffering before the surgery, they may feel relief during this stage. In-hospital rehabilitation then follows. This is an extremely critical stage. During this time, the greatest challenges will be presented to the patient, the patient’s loved ones, and the health care team. The patient may face a vast array of emotions, such as denial, anger, depression, and anxiety, and the goal is to bring them back to reorganization. It is also during this time that patients may experience phantom pain and sensations. Something that has been known to bring along encouragement and success is to introduce a successfully rehabilitated amputee to the current patient (Racy, 1992). The final stage is at-home rehabilitation. A major determining factor for the amputee’s adaptation is the family’s attitude and level of support. It is during this time that the full extent of the loss will be realized. However, amputees are completely capable of returning to a full and productive life (Racy, 1992).

Generally, the psychological difficulty increases with the age of the individual (Racy, 1992). Also, those who seem to be narcissistic about their appearance tend to have a negative reaction to amputation. To these individuals, it is an attack to their dignity and worth. Individuals who are dependent on others may accept the amputation relatively well and welcome the experience as a relief from responsibility. Individuals who have a history of depression are more prone to dysphoria, which is a state of unease or generalized dissatisfaction, after the surgery. For children and teens who must have amputations, their parents are the main resource for support. However, successful adaptation of amputees is also largely dependent on peer acceptance. The reason for the amputation also plays a role in how an individual will respond. For example, while one individual may react with denial, another individual who has been suffering from a chronic disease may welcome the amputation with relief. A vital component of amputation rehabilitation is vocational rehabilitation. Without this component, many individuals will not view their rehabilitation as successful. Individuals must see some form of resolution when they are posed with the loss of a skill, job, and means of support. Group support is a component of help that should be provided to amputees. One self-help group is Schwartz’s situation-transition (ST) group. For patients who have trouble in any of the stages described above, psychotherapy may be designated. Psychotherapy is also useful for those who are not able to resume a normal reality. Family therapy may also be needed (Racy, 1992).

Efficacy and effectiveness studies were done to determine whether psychological treatments truly provided beneficial results. The studies reviewed treatments dealing with depression, bipolar disorder, generalized anxiety disorder, social anxiety disorder, obsessive compulsive disorder, posttraumatic stress disorder, specific phobia, panic disorder, and coronary heart disease. The results of the treatment research revealed that it is shown that psychological interventions do indeed provide significant improvements in functioning. In fact, psychological intervention was beneficial in addressing the psychosocial aspects of even common physical conditions, such as coronary heart disease (Hunsley, Elliott, & Therrien, 2013).

Another study investigated psychological correlates after amputation. The results discovered significant differences in scores on the Hospital Anxiety and Depression Scale before and after therapy. These results indicate that it is beneficial for psychological intervention to be implemented into the rehabilitation and management after an amputation (Srivastave et al., 2010).

Phases of Multi-disciplinary Rehabilitation

When reviewing medical history, the therapist should pay special attention to history of heart disease. The therapist should be on the look-out for the following conditions: coronary artery disease, congestive heart failure, peripheral vascular disease, arteriosclerosis, hypertension, angina, arrhythmias, dyspnea, angioplasty, myocardial infarction, and arterial bypass surgery. It is crucial that the therapist obtains a thorough medical history of the patient. Medical records could contain information that is important for the development of the rehabilitation plan. Medications should also be monitored because certain medications have an effect on blood pressure and heart rate. Once the patient's heart rate and blood pressure have been observed during preliminary training, the intensity of the therapy may be increased as is appropriate. If any of the following symptoms are continually experienced by the patient, further medical evaluation is necessary: shortness of breath, pallor, diaphoresis, chest pain, headache, and peripheral edema (Gailey & Clark, 1992).

Physical rehabilitation requires the coordination and involvement of numerous medical disciplines. The rehabilitation process can be divided into four stages:

presurgical, immediate postoperative, prosthetic rehabilitation, and continuing care (O’Keeffe, 2011).

The presurgical phase may vary in duration, and it is dependent on the reasoning behind the amputation. In certain cases, a considerable amount of consultation time may take place. In scenarios pertaining to trauma, however, the consultation time could be minutes. Selecting a suitable amputation site, the surgical method to be exercised, and the immediate medical routine to be followed are activities that pertain to the presurgical phase (O’Keeffe, 2011).

During the postsurgery period, it is important that wound healing, edema resolution, and recuperation from any other injuries or pathologies take place. The length of this time period differs tremendously because it is dependent on the events that surrounded the amputation. In an ideal situation, this stage would last approximately three to four weeks, with the majority of this time being treated as out-patient. During the postoperative period, the amputee may be mobilized and pain management should commence. Counseling may also be provided during this time. Additionally, this is the time to begin developing the prosthesis possibilities for the amputee (O’Keeffe, 2011).

Following the postoperative period, the first task is to determine whether prosthetic rehabilitation is suitable for the patient. In some cases, choosing not to continue with rehabilitation may be appropriate. Nevertheless, in most cases, the delivery of a prosthesis and rehabilitation should be, at the very least, attempted. It has been noted that beginning rehabilitation as soon as possible after the amputation procedure amplifies the probabilities of long-term success. Success is less likely if the patient waits and attempts rehabilitation later on (O'Keeffe, 2011). Racy (1992) mentioned, "The earlier a prosthesis is applied, the less the psychological distress observed after amputation."

A number of things need to be evaluated during the postsurgical management period. The following need to be assessed: past medical history, mental status, range of motion, strength, sensation, bed mobility, and balance and coordination. The results of these evaluations will provide the therapist with insight on what is the most suitable assistive device for the amputee. Transfers, wheelchair propulsion, ambulation with assistive devices without a prosthesis, and cardiac precautions for the amputee are other topics that also need to be addressed. The patient's mental status must be evaluated to determine the level of cognition. The patient must be capable to comprehend and perform certain tasks, such as, donning and doffing the prosthetic limb, residual-limb sock regulation, bed positioning, skin care, and safe ambulation. If the evaluation determines that the patient is not capable of comprehending these activities, then it is imperative that family and friends become engaged in the rehabilitation. Doing so will increase the chances of better prosthetic care; active involvement of the patient and family members also raises the probability of a positive outcome (Gailey & Clark, 1992).

As with any medical procedure, complications are possible. A joint contracture is a complication that may arise for an amputee. A muscle contracture occurs when there is a permanent shortening of a muscle or joint. A joint contracture would hinder an amputee's progress because it would reduce the efficiency with which the patient is able to ambulate with the prosthetic limb. Caution needs to be taken to avoid joint contractures. The residual limb's range of motion should be measured and noted for future reference. Evaluation of the range of motion will tell the therapist whether the patient has a fixed contracture, or simply soft-tissue tightness. Soft-tissue tightness that occurs as a result of inactivity may be fixed within a relatively short time frame. Upper and lower range of motion may also have an effect on the way the prosthetic limb is constructed (Gailey & Clark, 1992). The trunk's and other major muscle group's strength must be evaluated. The level of functional strength will assist in establishing the possibility of the patient's capability of performing tasks such as transfers, wheelchair management, and ambulation (Gailey & Clark, 1992).

The sensation evaluation is important to not only the therapist but also to the patient. The patient must be educated on the importance of the results of this evaluation. The residual limb may experience insensitivity. If this occurs, this will have an impact on proprioceptive feedback, which is crucial for balance and single-limb stance. Gait complexities may arise if proprioceptive feedback is negatively affected. This means that the patient is at a higher risk for injury. Reduced pain, temperature, and light touch sensation further augment the risk of tissue breakdown and injury (Gailey & Clark, 1992).

Ensuring that the patient has good bed mobility has to do with much more than simply being able to move in and out of the bed or readjusting for comfort purposes. Proper bed posture is important for the prevention of the contractures that were discussed earlier. One also needs to avoid unnecessary friction between the sheets and the suture line and delicate skin. Help must be provided if the patient is unable to achieve movement and proper bed posture alone. It is important for patients to master this skill because it is the basis for other skills such as transfers from the bed to the wheelchair. Log rolling, followed by side lying to sitting, or supine lying on elbows to long sitting are two appropriate techniques for rolling, coming to sitting, or modifying one's position in the bed. Transferring is learned after bed mobility is grasped (Gailey & Clark, 1992).

Occupational therapists help patients of all ages to take part in the activities they desire to be a part of. Occupational therapists provide therapy by having their patients engage in everyday activities. Common involvements include assisting children with different disabilities to participate in school and other social activities and helping people recuperate from an injury and repossess their skills ("About occupational," 2016). For example, an occupational therapist would address activities of daily living in order to assist a patient with improving daily tasks with an upper limb prosthetic. Activities could include teaching the patient how to feed and dress himself.

The balance and coordination evaluation will demonstrate the patient's capability of sustaining the center of gravity over the base of support. Coordination is necessary for smooth movement and for the fine-tuning of motor skills. Balance and coordination are skills that are necessary for the transferring of body weight from one leg to another. Better balance and coordination are usually associated with a greater possibility for an improved gait. The results of these evaluations may suggest that the patient may begin ambulating with a walker. However, with proper instruction, the patient may grow to benefit more from devices such as forearm crutches instead (Gailey & Clark, 1992).

It is crucial that transfer skills be acquired early on. This skill transfers functionally as tasks such as moving to the toilet, shower, and car. Transferring capability must be assessed to reveal the extent to which the patient is capable of being independent (Gailey & Clark, 1992).

During the rehabilitation period, it is also important that wheelchair skills be instilled in the patient who underwent a lower limb amputation. For a large percentage of amputee patients, the wheelchair is the primary mode of mobility. For some degrees of amputation, the wheelchair conserves a substantial amount of energy. Being able to mobilize in a wheelchair is the first skill that will allow the amputee to gain independence (Gailey & Clark, 1992).

An important part of the rehabilitation process is patient education regarding limb management. The patient must be educated regarding the care of the sound limb and the residual limb. Additionally, the patient must be told to inspect the residual limb daily or after laborious activity. Any area that becomes reddened must be watched because it is a possible site for an abrasion. Prostheses should not be worn if a skin abrasion ensues. Once the area has healed, then it is safe to wear the prosthesis. Residual-limb wrapping is also important. The following are positive consequences that come about as a result of early wrapping of the residual limb: decreases edema and prevents venous stasis, assists in shaping, helps reduce the likelihood of contractures in a transfemoral amputee, protects the skin, decreases unwanted tissue problems, reduces phantom limb pain, and desensitizes the limb with local pain. It is crucial that the application of the elastic bandage or residual limb shrinker be applied properly for several reasons. Proper application averts circulation constriction, poor residual limb shaping, and edema (Gailey & Clark, 1992).

Exercise Prescription

There are numerous preprosthetic exercises the physical therapist can instruct patients to perform. Eisert and Tester’s antigravity exercises have been the preferred tactic for strengthening the residual limb (Gailey & Clark, 1992). In addition to strengthening, these exercises also improve desensitization, bed mobility, and joint range of motion. Strength improvements may also be amplified by integrating isometric contractions at the peak of the isotonic movement. As mentioned earlier, trunk strength is of vital importance. Patients can greatly benefit from abdominal and back extensor strengthening exercises. These types of exercises will preserve trunk strength, reduce the probability of back pain, and reduce gait deviations (Gailey & Clark, 1992).

Preventing contractures and a reduction of range of motion is of major importance because a limited range of motion may result in troubles with the prosthetic fitting, gait, and the incapacity to ambulate completely. Staying active is key to avoiding a loss of range of motion. For some amputees, this is difficult. For those amputees for whom remaining active is not an option, proper limb positioning is crucial. All amputee patients should be told that sitting in a wheelchair for prolonged periods of time may advance to limited motion during ambulation due to limited hip extension (Gailey & Clark, 1992).

Performing physical activity soon after surgery has produced a better recovery. This is true for several reasons. 1). The negative effects of immobility are counteracted by stimulating movement in the joints. 2). Muscle activity and circulation are also promoted. 3). The sooner activity is resumed, the sooner the patient may start to establish independence .4). The psychological advantage originated from the increased activity level and independence will encourage the patient and keep them progressing during the rehabilitation period (Gailey & Clark, 1992).

A progressive, general exercise program should be directed to each patient and started as soon as possible after surgery. Struggles that arise during learning functional activities and during gait training often stem from a reduction in general conditioning and endurance. The exercise program should be continued through the preprosthetic period, and eventually, it should be integrated into their daily schedule. The following is a list of recommended general conditioning and endurance exercises: cuff weights in bed, wheelchair propulsion for a predetermined distance, dynamic residual limb exercises, ambulation with an assistive device prior to prosthetic fitting, lower or upper limb ergometer work, wheelchair aerobic, swimming, aquatic therapy, lower and upper body strengthening at a fitness center, or any sport or recreational activity that the patient is interested in. One or more of these options should be selected. Participation should be to tolerance at first, and then progressed to an hour or more a day. Participation in these activities does much more than increase the probability of good ambulation with a prosthetic limb. Additionally, the patient is able to feel and revel in the activities that were once thought of as impossible. If troubles are faced, the amputee is still in a safe environment where assistance and encouragement are available from the physical therapist or from another amputee who has already overcome and mastered the activity (Gailey & Clark, 1992).

Prior to ambulation without a prosthetic, patients must learn how to counterbalance the loss of weight (the amputated limb) by balancing their center of gravity over their sound limb. Although this is not how ambulation takes place with a prosthesis, this single-limb balance must be acquired first to supply confidence during stand pivot transfers, ambulation with assistive devices, and hopefully, later on, hopping. Here is an example of one approach to progressive ambulation. The amputee begins by standing inside of the parallel bars and holding on to both bars for assistance. The next progression would be to remove the hand from the bar on the same side as the limb that was amputated. Next, both hands are to be taken off of the bars. The final challenge inside of the bars would be for the patient to tap the shoulders in different directions or to toss a ball back and forth. Once there is confidence in this skill, the patient may practice these skills outside of the pars. A progression from this exercise could be hopping activities (Gailey & Clark, 1992).

An assistive device is a tool that helps an individual do tasks and move around. It may also help you do other things, such as communicate or eat ("Assistive devices," 2016). While some patients will still require an assistive device even when they are wearing their prosthetic device, all amputees require an assistive device for when they do not wear their prosthetic. An assistive device is also necessary when an amputee is unable to wear the prosthesis due to edema, skin irritation, or poor prosthetic fitting. Assistive devices include walkers, forearm crutches, and quad or straight canes (Gailey & Clark, 1992).

A goal of rehabilitation is to restore the gait biomechanics that were distinctive of a person before the surgery. Gait training aims to restore the function of the joints that remain in the amputated limb. Gait training should never change the patient's walking mechanics for the prosthetic limb; rather, the prosthetic limb should be created to fit the patient's gait pattern. Stairs, uneven surfaces, ramps, hills, sidestepping, backward walking, multidirectional turns, tandem walking, braiding, single-limb squatting, and running skills are advanced gait training activities (Gailey & Clark, 1992).

Conclusion

Although it is a difficult and long process to recover from losing a limb, with advances in technology and improving physical therapy methods, individuals are now able to once again participate more fully in the everyday activities of life.

In order to provide the best and most comprehensive care for the patient, the physical therapist, prosthetist, and rehabilitation team must work closely together. Each program must be individualized, for each patient's skills and abilities are different. In summary, the goal of the health care team is to make this period of time as smooth and successful for the patient as possible, both psychologically and physically (Gailey & Clark, 1992).

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