

Prosthetic Ambulation in a Paraplegic Patient with a Transfemoral Amputation and Radial Nerve Palsy

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Abstract

Great importance and caution should be placed on prosthetic fitting for a paraplegic patient with an anesthetic residual limb if functional ambulation is to be achieved. The combination of paraplegia with a transfemoral amputation and radial nerve palsy is a complex injury that makes the rehabilitation process difficult. This article describes a case of L2 paraplegia with a transfemoral amputation and radial nerve palsy on the right side. Following the rehabilitation course, the patient independently walked using a walker at indoor level with a transfemoral prosthesis with ischial containment socket, polycentric knee assembly, endoskeletal shank and multiaxis foot assembly and a knee ankle foot orthosis on the sound side. The difficulties of fitting a functional prosthesis to an insensate limb and the rehabilitation stages leading to functional ambulation are reviewed.

Key Words: Paraplegia, transfemoral amputation, prosthetic ambulation

INTRODUCTION

A transfemoral amputation causes total body asymmetry, a change in the center of gravity, and a tendency for the development of abduction and flexion contractures of the hip. Before a patient with paraplegia and transfemoral amputation can achieve ambulation, the following difficulties must be addressed: A significant disturbance in weight shifting and balance reaction caused by the amputation; A lack of muscle strength beneath the injury level; and an anesthetic residual limb which disturbs prosthetic fitting, due to the increased possibility of chafing and pressure sores when sitting in a wheelchair and even more so when ambulating.¹

The combination of paraplegia with lower limb amputation complicates the rehabilitation process, particularly if the patient is highly motivated to return to ambulation. Treatment requires relating to the neurological and orthopedic impairments both separately and concurrently.¹

This case was an example of a unique rehabilitation

outcome in which full wheelchair independence and functional ambulation were achieved in a patient with combined L2 paraplegia due to cauda equina injury, right transfemoral amputation and right radial nerve palsy.

CASE REPORT

The patient was a 30-year-old married Korean man with one child who was self-employed. On December 27th, 1997 he had traffic accident and was subsequently diagnosed with a right humerus fracture, an open comminuted fracture of the right tibia and fibula, Grade IIb.

The patient underwent surgery the same day in order to stabilize the open tibiofibular fracture. At postoperative 5th day following stabilization of the open tibiofibular fracture, he sustained lower back pain with paralysis at the L2 level (neurological level). The simple X-ray and CT scan showed an L2-3 fracture and dislocation with an L3 spinous process fracture and lamina fracture. The patient underwent surgery on January 3rd, 1998 to stabilize the spinal fracture via spinal segmental instrumentation of L2-L4. The postoperative recovery was uneventful.

On January 6th, 1998, the surgical site of the right leg appeared infected. Pus discharge from the wound

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site showed a necrotic change in the underlying soft tissue. Intravenous antibiotic, antibiotic bead and aseptic dressing were immediately applied. However extensive bone loss and soft tissue necrosis were remarkable at the postoperative 11th day. Therefore, on February 23rd, 1998, the orthopaedic surgeon amputated the right leg at the transfemoral level.

On March 12th, 1998, the patient was transferred to Department of Rehabilitation Medicine. The length of the right residual limb was 37 cm from the greater trochanter and conical in shape. The scar was fish-mouthed, clean, and closed, but showed incomplete shrinkage. A neurological examination showed a normal cognitive status and an incomplete flaccid paraplegia below the L2 level. On a manual muscle test, the left upper extremity showed a normal grade. The strength of the right shoulder muscles also showed normal except that the right elbow extensor showed a fair grade and the right wrist extensor and right finger extensors were zero grade. The right hip flexors and extensors showed a poor grade and abductors, trace grade and adductors, zero grade. The left hip flexors showed a trace grade and others, a poor grade. Below the knee showed zero grade. The joint range of motion (ROM) was passively full. Upon sensory examination, the last intact level was L2 dermatome, with anesthesia and analgesia below L3 dermatome. The patient showed no perianal or deep anal sense. Electrodiagnostically, no response in either the bulbocavernosus reflex latency or pudendal somatosensory evoked potential, and nerve conduction study and needle electromyography in both lower extremities implied cauda equina injury and complete injury of the right radial nerve at or around the elbow level.

The patient appeared to be depressed. The consulting psychologist believed that the major aspect of his depression was caused by on a dependency and necessity for the nursing staff to be present for all aspects of his personal care, as well as by the effects of the paralysis and amputation on his body image. Before the injury, he was a successful businessman who prided himself on total independence in all aspects of his life. Thus, the additional problems of loss of control, contact with his family and business increased his feelings of frustration and helplessness. The fact that the patient's family lived far away added to his loneliness.

Rehabilitation course

The first few weeks were dedicated to managing the residual limb with the desensitizing of phantom and stump pain and wrapping for shrinkage of the distal residual limb. For the prevention of contracture of the right wrist and muscle atrophy of right wrist and finger extensors, electrical stimulation therapy and static wrist-hand orthosis were given to the patient. The treatment course consisted of upper extremity strengthening, maintenance of joint ROM, and standing with the aid of a tilt table. To ensure symmetrical weight-bearing and to minimize poor body image secondary to the amputation, the patient was fitted with an ischial containment socket with suspension liner using silicone for stability (instead of a quadrilateral socket for mobility), polycentric knee joint with manual locking, and endoskeletal shank and multiaxis ankle foot assembly (Fig. 1 and 2). While his left lower extremity's knee-ankle-foot orthosis (KAFO) consisted of a drop ring-locked knee joint, limited ankle joint and high-top shoes with velcro closure.

We were then able to gradually elevate the patient from sitting on a wheelchair to the vertical position, allowing standing at an early stage. He also began standing in the parallel bars with a KAFO and a prosthesis allowing pressure and weight-bearing on the residual limb. The time spent standing was gradually increased from 10 minutes on the first day to 90 minutes at 2 weeks. The skin was observed frequently during the standing trials to monitor for chafing and excessive pressure. The patient progressed to a reciprocal gait in the parallel bars. The patient achieved ambulation appropriate for a L2 paraplegic. During his rehabilitation, minimal neurological improvement was noted along with a slight increase in strength of the right hip flexor, but no interval change in right radial nerve injury was observed. All other lower extremity muscle groups did not contract voluntarily. At discharge, the patient could propel the wheelchair independently. While clothed, he was able to provide pressure relief of the residual limb by unlocking and partially removing the prosthesis in the wheelchair. He could stand independently and return to sitting with the aid of a walker (Fig. 3). He could ambulate about 10 meters on a level surface. He was discharged on August 5th, 1998 in a functionally independent wheelchair level and was planning to

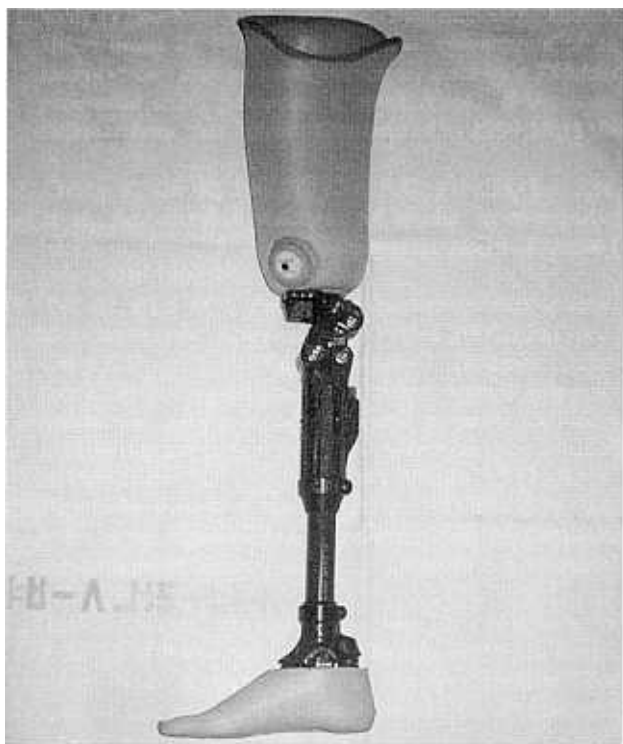


Fig. 1. A trans femoral prosthesis; Fig. 2. Ischial containment ischial containment socket with suspension, socket, anteroposterior view polycentric knee joint, endoskeletal shank and multiaxis ankle foot assembly.



Fig. 2. Ischial containment socket, anteroposterior view.

return to work.

Six months after discharge, he continued to wear the orthosis and prosthesis for up to 6 hours a day



Fig. 3. Independent standing and ambulation with the aid of walker.

and, continued gait training without any problems such as pressure sores. He showed an improvement in both walking endurance to about 50 meters on a level surface and in dynamic standing balance.

DISCUSSION

Great importance and caution should be placed on prosthetic fitting for a paraplegic patient with an anesthetic residual limb if functional ambulation is to be achieved.¹

Tsirul'nikov et al. found a direct link between the level of local sensation, muscle strength, and successful prosthetic fitting in pediatric patients with upper extremity amputations.² Additionally, there is a direct link between the level of functional independence achievement and the following basic conditions of amputation on the paretic side of the lower limbs; at least fair grade muscle strength, intact sensation and coordination on the paretic side, and

normal mental status.³

O'Connell and Gnatz found that the factors that influenced ambulation were age, severity of the cerebrovascular accident from the standpoint of muscle weakness and spasticity, level of amputation, and premorbid ambulation history.⁴ Tuel et al. described a 24-year-old paraplegic patient who underwent a hemi-corporectomy secondary to complications.⁵ He was fitted with a prosthetic seating insert. He achieved complete independence in activities of daily living at a wheelchair level, as well as "hand walking". Ohry et al. discussed six patients with spinal cord injuries and varying levels of amputation.⁶ They noted that during physical and psychological rehabilitation, there were changes in posture and low back pain, and that pressure sores developed on the residual limb. The outcomes of prosthetic fitting for these patients were not successful. Heim et al. emphasized that fitting with a functional or cosmetic prosthesis is contraindicated when sensation is absent in the residual limb.⁷

Therefore, in our case, the prosthesis must meet the following criteria:

First, there must be a superior fit of the socket in order to guarantee stability, maximize control, and prevent pressure sores and chafing. Second, it must allow independent donning and doffing by the patient. And third, it must be lightweight.

We considered several possible prosthetic designs. A quadrilateral total contact suction socket was rejected because of the difficulty in donning and the piston action within the sockets. A reciprocal gait orthosis with a permanently affixed prosthesis was rejected because of the complexity and difficulty in donning it and the danger of chafing caused by the fixed socket design. Finally, an ischial containment prosthesis (contoured adducted trochanteric controlled alignment method) was selected because the socket allows better dispersal of pressure on the entire residual limb and minimizes local pressure on the ischial tuberosity.^{8,9}

The socket is comprised of a silicone sleeve, inner socket, and a hard outer socket. The sleeve is made of a very soft stretchable silicone material, with extraordinary elongation and tear-resistance capability. This silicone sleeve is easily donned and it conforms and adheres well to the residual limb. After being turned inside out and rolled over the stump, the silicone sleeve forces the skin in a distal direction,

stabilizing the soft tissue and minimizing pistoning. It also provides a layer between the skin and the socket that absorbs pressure and shearing forces, thereby reducing the possibility of developing pressure sores or chafing. The interface between skin and socket is free of friction, which has been transferred to the interface between the ICEROSS (ICEROSS, Ossur Kristinnsson, Ossur hf, Box 5288, Reykjavik, Iceland) and the socket, resulting in less strain on the skin.¹⁰ A shuttle lock at the edge of the silicone sleeve attaches to both the inner and outer socket. This locking mechanism minimizes any piston action.¹¹⁻¹³

We changed the alignment of the prosthesis for stability and the calf portion was placed forward while the knee axis was placed 4 cm behind the line of gravity in order to provide for the unique stable posture a paraplegic requires while standing, in a usual transfemoral prosthesis the knee axis is 1 cm behind the line of gravity.¹⁴ After changing the alignment of the prosthesis, he was satisfied with the greater stability while standing.

During the rehabilitation period, the patient showed high motivation and displayed responsibility in maintaining skin integrity and in preventing complications. His strong will contributed greatly to the team's decision to fit him with a prosthesis despite the attendant difficulty and danger.

In conclusion, the lack of sensation in a residual limb generally is a contraindication to prosthetic fitting of a functional or cosmetic limb. In an insensate transfemoral residual limb, there would be an increased danger of pressure sore, particularly on the ischial tuberosity and adductor longus tendon that are subjected to constant pressure. In recent years, our center has rehabilitated several patients who have had a combined spinal cord injury or stroke with concurrent amputation. Some patients developed pressure sores on the residual limb and others were able to achieve only partial independence. The possibility of fitting a prosthesis to an insensate limb should not be summarily dismissed. Each case should be considered individually, with the decision being based on the individual's personality and his (or her) physical and psychological condition. A trial on prosthetic fitting and training is appropriate if the potential risks and benefits warrant it and if the appropriate precautions and supervision are undertaken.

This case represents a breakthrough in the rehabilitation of concomitant injuries and broadens the

range of solutions that can be offered to patients.

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