Early Standing through Prosthetic and Orthotic Fitting in Transtibial Amputation and Multiple Limb Fractures: A Case Report

Sang Won Hwang, M.D., Sang Hee Im, M.D., Ph.D., Min Cheol Ha, M.D. and Ji Cheol Shin, M.D., Ph.D.

Department and Research Institute of Rehabilitation Medicine, Yonsei University College of Medicine, Seoul 03722 Korea

하퇴 절단 및 다발성 골절 환자에서 의지 및 보조기 장착을 통한 조기 기립 훈련: 증례보고

황상원 · 임상희 · 하민철 · 신지철

연세대학교 의과대학 재활의학교실 및 재활의학연구소

Abstract

Lower limb amputation due to an external injury is commonly accompanied by fractures in the other limb, and this results in delayed mobilization with prosthetic fitting of the amputee side until complete healing of the fracture. Many cases often result in a poor rehabilitative outcome as excessive immobilization causes muscle atrophy, joint contracture, synovial adhesions, and cartilage degeneration. A 75-year-old man had a crush injury and underwent transtibial amputation of the right leg and external fixator insertion for the left tibial shaft open fracture. From postoperative day 7, early standing training was performed by applying the prosthesis on the right leg and orthosis on the left leg to control the weight load. One year later, this geriatric patient could walk independently. This case report reveals an exemplary good outcome of early standing training in a geriatric patient for complicated lower limb amputation with other limb fractures.

Key Words

Amputation, Early mobilization, Fracture healing

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Corresponding author : Ji Cheol Shin, M.D., Ph.D., Department of Rehabilitation Medicine, Yonsei University College of Medicine, Seoul 03722 Korea
Tel : 82 2 2228 3710
Fax : 82 2 363 2795
e-mail : jcsevrm@yuhs.ac

Introduction

Traumatic amputation of the lower limbs commonly affects one's standing and walking ability depending on the degree of damage to the ipsilateral or contralateral lower limb.[1] In complicated amputation with fractures, prosthesis fitting is generally performed after bone union has progressed, resulting in delayed wearing and training of the prosthesis and a longer immobilization period than in a simple case.

Excessive immobilization can lead to poor rehabilitation outcomes.[2] Prolonged limitation of mobilization can also inhibit the proliferation of inflammatory cells required for reproduction. This inhibits the development of blood vessels, further delaying bone healing.[3] Therefore, the method of

promoting bone healing should be considered while shortening the bedridden period in patients with fractures. When full-weight bearing and active exercise were performed using braces in unstable fractures of the ankle, fractures healed without displacement in all patients.[2] Additionally, weight bearing without excessive exercise was helpful for bone healing in rats.[4] We describe an exemplary good outcome of early standing with weight-bearing training in geriatric patient for complicated lower limb amputation combined with other limb fractures.

Case Report

A 75-year-old man suffered a crush injury caused by a metal beam on October 19, 2013. The lower third of the right tibia was injured, and he had open fractures of the left tibia and left wrist. On the day of the accident, he underwent transtibial amputation of his right leg (Fig. 1). After amputation, he was transferred to orthopedic department of our tertiary hospital as he required stepwise operations for multiple fractures. After admission on October 23, 2013, he underwent stepwise surgery, open reduction, and internal fixation for the medial condyle of the left femur on October 24, 2013. After orthopedic surgery, consulted rehabilitation therapy was started on November 5, 2013. The early rehabilitation program for multiple trauma included range of motion exercise of the amputated leg to prevent contracture and isometric exercise and progressive muscle strengthening of the fractured leg to prevent muscle atrophy. On November 11, 2013, external fixation was removed, and closed reduction and internal fixation of the left tibia were performed (Fig. 2A). On November 26, 2013, open reduction and internal fixation of the left radial fracture were performed.

On the completion of this last operation, he was transferred

Fig. 1. Transtibial amputation of the right lower extremity.

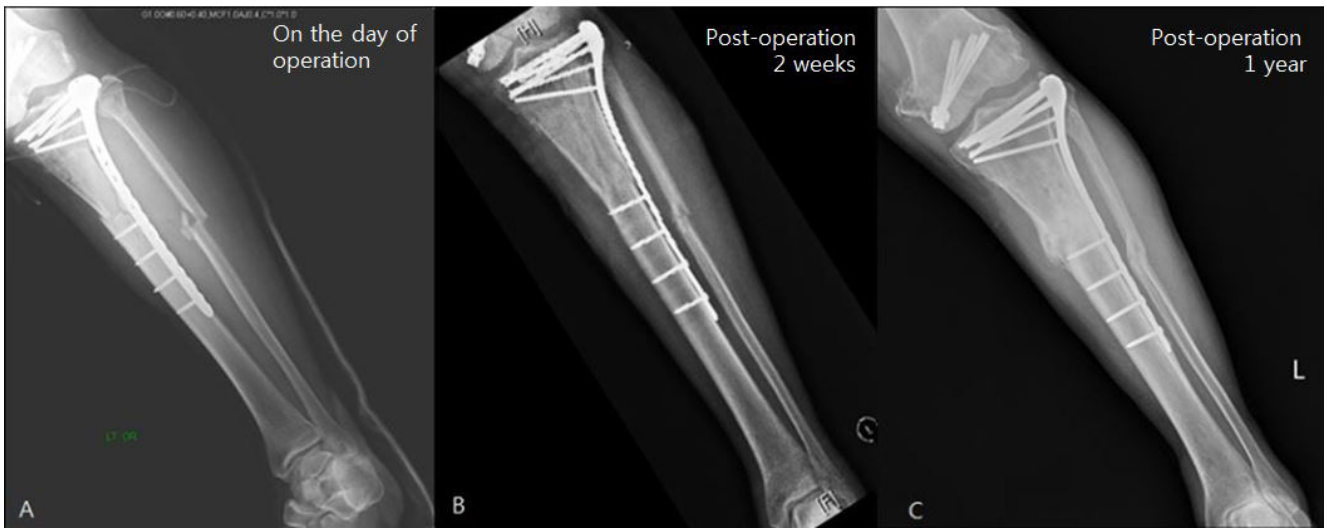

Fig. 2. Progression of bone union on serial x-rays of the left tibiofibular fracture. (A) Postoperative status, B) time of transfer to rehabilitation, and (C) 1 year after injury

Fig. 3. Maturation of the amputated stump.

to the department of rehabilitation medicine. The fixation of his fractured leg was stabilized (Fig. 2B). The right transtibial amputation site healed in a cylindrical shape, and the tibia length was 171.2 mm, 39.4% of the length of the contralateral side (396.5 mm). Soft tissue shrinkage progressed well, and no bony spur or neuroma was observed (Fig. 3). The phantom pain was improved rapidly. There was no limitation of joint movement, and according to the manual muscle test, the left upper extremity was confirmed to be grade 4, right upper extremity was grade 5, and hip muscle of both lower extremities was confirmed to have normal grades, except for the right hip extensor, right knee flexor, and right knee extensor, which were grade 4. The left extensor hallucis longus (EHL) was grade 2, left ankle dorsi-flexor was grade 1. For the weakness of left ankle dorsiflexor and EHL, electromyographic evaluation of the left lower leg weakness was performed, and incomplete common peroneal nerve injury was confirmed.

The prosthesis was prescribed after assessing underling cardiopulmonary function, nutrition, and psychologic status. The patient initiated partial weight bearing using a tilt table twice daily, with the prosthesis on the amputated leg and knee ankle foot orthosis (KAFO) with a dial-lock knee joint on the opposite leg. His prosthesis was composed of a patellar tendon-bearing socket, silicon suction-type suspension, an endoskeletal shank, energy-storing ankle, and a dynamic response foot (Fig. 4). The purposes of standing were to promote bone healing, strengthen the lower extremities, and ultimately enable gait.

On December 19, 2013, he was discharged home and performed self-exercise for 4 months while waiting for complete healing of the left upper limb and lower leg fractures.

Fig. 4. Prosthesis for early mobilization.

Before the second admission, he performed self-exercises including stretching and strengthening of the lower limbs. Weight-bearing exercise with the prosthesis continued.

On April 9, 2014, he was re-admitted for gait training. The x-ray still showed incomplete healing of the left tibiofibular fractures but with the presence of callus formation (Figure 2C). His KAFO was modified so the dial lock of the knee joint could be opened for gait training. He initiated walking while holding a parallel bar from April 10, 2014. Enough weight bearing to promote bone union was applied without a full-weight load to the fractured side. Gait training gradually progressed to walking with a mono-cane from May 13, 2014 and walking on a ramp from May 30, 2014. One year after the injury, he could ascend and descend stairs while holding a bar, and his lower leg fractures were healed.

Discussion

Complicated amputation with multiple fractures may be accompanied by various complications that may delay rehabilitation, and long immobilization leads to additional complications. After 9 days of internal fixation of the fractured

left leg, our elderly patient started tilt table standing using the prosthesis on the right leg and KAFO on the left leg. This therapy facilitated bone union, enabling faster functional recovery, and even level walking training was possible within 6 months of injury onset.

Early mobilization through functional bracing is mainly performed after amputation and internal fixation surgery.[5] Sarmiento et al. confirmed that motion of the fracture site promotes osteogenesis through early weight bearing during acute fracture. The callus produced by this process is a stronger material than that produced by immobilization.[6] Pathophysiologically, local irritation of soft tissue surrounding these fracture sites induces vascular invasion, resulting in stronger callus formation. Controlled weight bearing has the additional effect of preventing cardiopulmonary complications in elderly patients. However, inadequate early mobilization does not promote callus formation and can lead to non-union or malunion. These negative results could be prevented by controlling the degree of weight bearing.

In patients aged 70-79 years, unilateral transtibial amputation was graded as IV (limited community ambulator) according to the Volpicelli ambulatory status scale at the 1-year follow-up.[7] Several tools for evaluating mobility in addition to the Volpicelli ambulatory status scale have been proposed in patients with amputation, and K level is frequently evaluated clinically.[8] In another study, patients with unilateral transtibial amputation who underwent household and community ambulation at the 1-year follow-up were 65-79 years of age (64% and 49%, respectively) and 50 years of age (100% and 92%, respectively).[9] However, the above results were limited to one leg amputation without any injury of the contralateral limb.

In post-amputation status, amputated patients need more energy for walking than normal persons as they need adaptation to the prosthesis.[10] Elderly patients need more time for adaptation and consume much energy for walking than younger ones, and even much more in multiple fractures rather than in simple amputations. Although our patient was 75 years of age, he was able to use stairs within a year after his injuries, suggesting that step-by-step rehabilitation minimizes complications that may occur due to immobilization for a long time in elderly individuals.[11]

In our case, the initial prosthesis and orthosis served to provide axial force through standing. Early standing with the proper prosthesis and orthosis promoted bone healing, restored the patient's physical condition, and shortened the duration of rehabilitation.

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