Case Report
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Acute Shortening and Delayed Lengthening in Management of Lower Leg Amputation: A Case Report

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Acute bone shortening and delayed lengthening by Ilizarov surgery have been used to treat a wide range of soft tissue injuries including open fracture, osteomyelitis of the tibia and lower leg amputation. It has advantages such as bone lengthening as well as minimizing the loss of damaged tissues via tissue expansion. Here, we report a case of 52-year-old male with satisfactory results through acute bone shortening, replantation, and gradual bone lengthening after complete amputation of the ankle with related literature reviews.

Key Words: Bone lengthening, Amputation, Ilizarov surgery

Open fracture, traumatic amputation, and osteomyelitis accompanied by soft tissue and bone loss are not easy to treat and they cause many complications in the lower leg. Tissue graft such as a free flap graft is prone to failure when injury to the blood vessel occurs, and bone graft alone does not solve the problem of a shortened lower leg.[1-3] Moreover, when such a conventional treatment fails, it is difficult to select an alternative surgical method.[4,5] To overcome these drawbacks, acute bone shortening and gradual lengthening by Ilizarov surgery, which has advantages such as bone lengthening as well as minimizing the loss of damaged tissues via tissue expansion, is being used to treat a wide range of soft tissue injuries including open fractures of the tibia and osteomyelitis.[1-5]

Here we present our case which achieved satisfactory results through acute bone shortening, replantation, and gradual bone lengthening after complete amputation of the ankle with related literature reviews.

CASE REPORT

A 52-year-old male patient was admitted to the emergency room with a crushing injury and amputation of his right ankle. On physical examination, complete severance of the proximal part of the right ankle except for medial skin and damaged, contaminated surrounding tissues without palpable dorsalis pedis and posterial tibial arteries were observed (Fig. 1). A short leg splint was applied after saline irrigation was performed. Emergency operation was performed 3 hours after

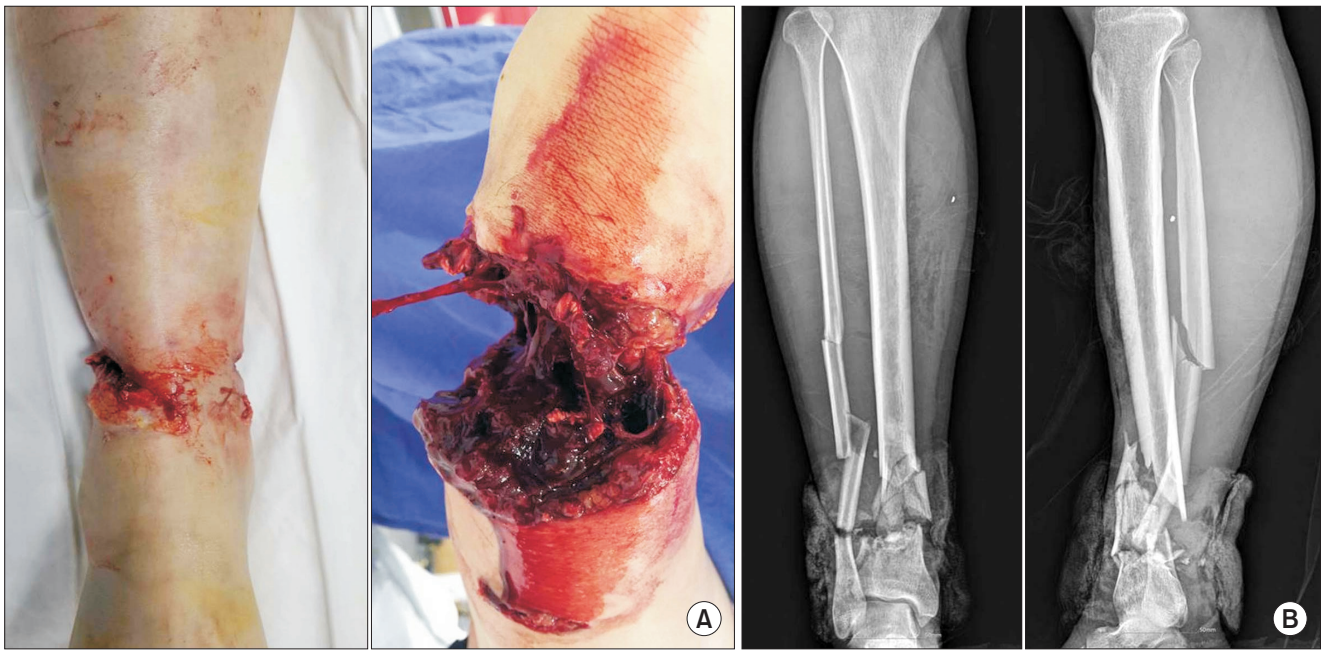

Fig. 1. Photographs (A) and radiographs (B) showing amputation with comminuted fracture of the tibia and fibular at above ankle joint.

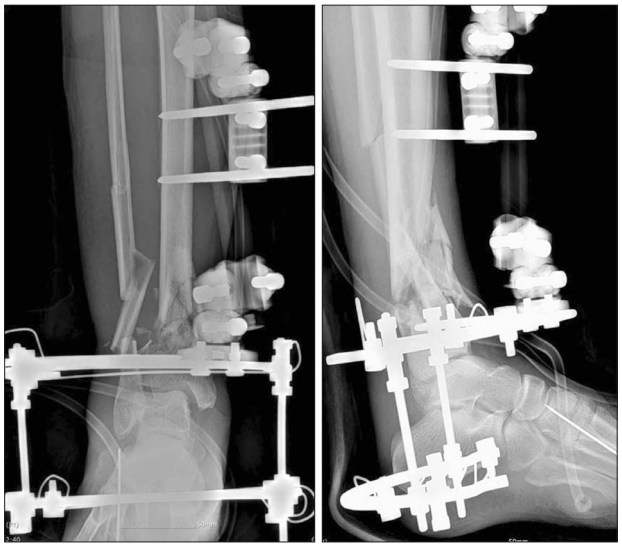

Fig. 2. Radiographs showing acute shortening at defect site by external fixator after revascularization.

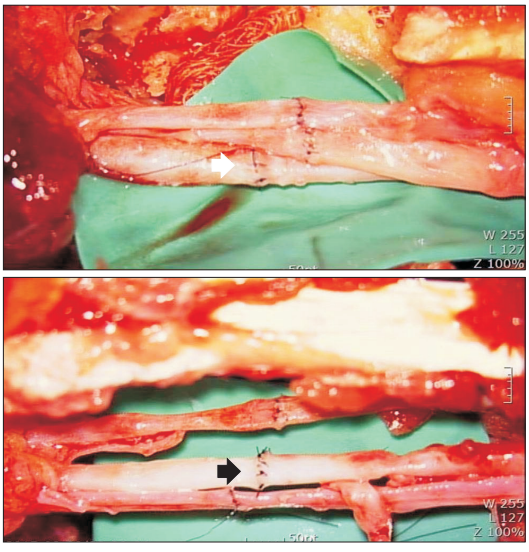

Fig. 3. Photographs showing vascular anastomoses (white arrow: anterior tibial artery, black arrow: posterior tibial artery) at the amputation site.

trauma. Massive debridement was done while eliminating the possible contaminated tissue around the amputation area of the right ankle. Adequate irrigation and removal of contaminated bony debris were done in the fractured area, while maintaining the contact surface of the fracture as wide as possible. External fixation was done by using a hybrid-type mono fixator after 4 cm acute shortening which was performed for anastomosis of the vessels and nerves while maintaining bony alignment (Fig. 2). After confirming the stability of the fractured site, we anastomosed the posterior tibial artery, the surrounding vein, the tibial nerve, and the posterior tibial and flexor tendons in that order. Achilles tendon repair was performed and the anterior tibial artery, surrounding veins, and the deep peroneal nerve were anastomosed. Also, the anterior tibial, extensor and

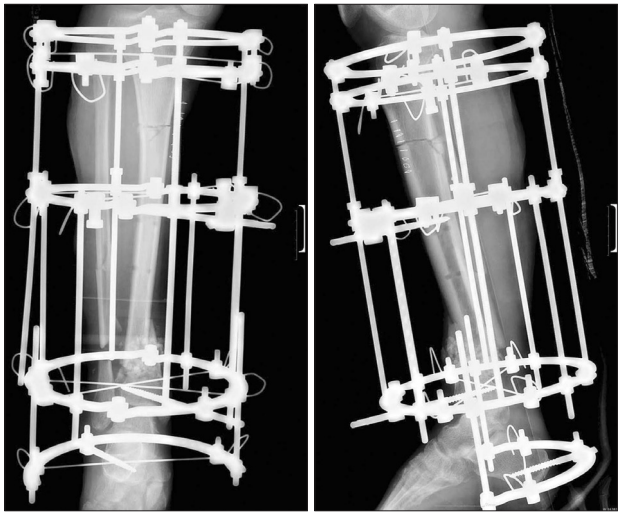

Fig. 4. Radiographs showing corticotomy at proximal metaphysis of the tibia by Ilizarov technique.

Fig. 5. Radiographs showing union at the shortening site and additional plate fixation at the lengthening site 6 months after removal of Ilizarov apparatus.

peroneal tendons were repaired (Fig. 3).

Gradual lengthening at the proximal tibia by Ilizarov apparatus and bone grafting at the shortening site were performed after about three months following confirmation of the replantation site (Fig. 4). The targeted goal of distraction was 4 cm at a rate of 1 mm/day. External fixator was removed 6 months after bone lengthening and additional fixation was performed using a locking plate, and the healing index was 42.6 days/cm (Fig. 5). Out-patient examination after 2 years from the operation showed 5° extension limit of the right knee joint, 10° active range of motion of the right ankle, and 1.5 cm leg length discrepancy on a lower leg scanogram. On clinical evaluation, the American Orthopaedic Foot and Ankle Society score was 58 points and the patient was able to walk without crutches with a slight decrease in the sensation in his dorsal foot and sole.

DISCUSSION

Acute bone shortening and gradual lengthening are useful treatment options in open fracture with surrounding tissue damage, traumatic amputation, non-union, and osteomyelitis.[1-5] It has shown particularly good results in Gustilo-Anderson types 3A and B open fractures with bone and skin loss, and it has advantages such as a relatively short treatment time, wide range of debridement via bone shortening, minimum skin loss and leg length discrepancy via bone lengthening.[3,4,6] It also has the advantage of reducing the tension at anastomosis, which makes it possible to perform a primary suture without the need for a blood vessel or nerve graft, as in our case.

There are various reports regarding the degree of acute bone shortening. Yokoyama et al.[7] mentioned that it was difficult to obtain a satisfactory result if 25% shortening of the normal leg length occurs, even though one could decide the length of shortening according to the possible range of primary closure after extensive debridement. Other authors[2,4,8] reported that they decided on the range of shortening by checking the pulse on palpation on the distal part of the lower leg or by Doppler sonography while performing the shortening procedure. We performed 4 cm bone shortening, which made it possible to do a primary closure and to minimize tension after anastomosis of the nerve and vessels in our case. Of course, it is necessary to perform excessive amount of bone shortening if the degree of contamination of the wound or bone loss is severe. An approximately 1.5 cm leg discrepancy does not affect walking or functioning, which could be done to allow for easy toe clearance on purpose occasionally.[9] Thus, we think that sufficient bone shortening is necessary and it is better than performing lesser shortening in order to achieve stable wound care and bone union within the range of 25% to the normal tibia.

It is necessary to consider the duration of application while performing bone lengthening using external fixation. The longer is the duration of application, the more are the

complications such as infection, unstable joint, stiffness, re-fracture after removal of the fixator.[10] This is particularly true in cases of application of an external fixator over a longer period for a complex open fracture and amputation wound, which have contaminated surrounding tissues. We can consider gradual lengthening by external fixation, in which a plate or an intramedullary (IM) nail is inserted to reduce this complication. It has the drawback of requiring an additional procedure, which is performed for removing the plate or IM nail after bone union, but it can be attempted in cases of contaminated tissue cases or those requiring early union like our case to prevent the complications.

There is currently no definite standard about when bone lengthening should be performed. Basic principles are avoiding bad influence and tension, which can cause re-rupture of the vessel or nerve after anastomosis, on the wound. But it may require a great deal of time to begin bone lengthening procedure because we cannot predict the time needed for achieving bone union at the shortening site or wound stability. Parmaksizoqlu et al.[3] reported that they could perform early bone lengthening as soon as stability of the wound and patient were achieved to minimize the required time of treatment after trauma. El-Rosasy[4] also insisted that early bone lengthening was necessary because delayed surgery could cause contracture of the surrounding tissue, which makes it difficult to obtain adequate lengthening and is associated with a higher complication rate. In this present case, we performed proximal tibial bone lengthening at about 3 months after acute bone shortening. It took 3 months to achieve bone union and wound healing, and we believe that inadequate debridement may have led to a longer healing time. It is believed that a lot of effort is required to succeed in achieving early bone lengthening, which includes extensive debridement and careful attention for achieving bone union at shortening site.

We conclude that acute bone shortening and delayed bone lengthening are useful treatment options for patients with lower extremity amputation to minimize soft tissue loss and achieve easy anastomosis of the vessel and the nerve.

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