Case report

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Repair of tibial bone defects with fibular fragment and the induced membrane technique

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Introduction High-energy tibial fractures are challenging injuries to treat. **Objective** We report a case of a tibial gunshot fracture treated at several stages. **Material and methods** The fracture was first stabilized with external fixation device. The second stage aimed at the arrest of infection consisted of excision of necrotic tissues, placement of antibacterial spacer and repair of compromised soft tissues. Reconstructive surgery was produced at the third stage of treatment to address bone defect and provide consolidation. **Results and discussion** The Masquelet induced membrane technique, compression osteosynthesis with the Ilizarov frame and non-free autograft using fibular fragment facilitated recovery of supporting tibia functions within a relatively short period of time. **Conclusion** The combination of stimulating effects from different surgical techniques is useful to ensure a good outcome in a severe clinical case scenario.
Keywords: bone defect, Ilizarov technique, autograft, Masquelet membrane

INTRODUCTION

Acute bone defects are caused by high-energy injuries. Gunshot injuries are the leading cause of traumatic loss in tibial fractures. The problem of how to manage tibial fractures associated with extensive bone defects and infection of subjacent tissues resulting from road traffic accidents, current conflicts and military operations, large-scale disasters is now the most challenging problem that orthopaedic traumatologists encounter. Treatment of the patients is based on damage control approach and involves technical, social and economic aspects. Infectious complications lead to delayed wound healing and lower limb amputation. Traumatic bone loss, the removal of all debris along with devitalized and infected tissue during initial and repeat debridements result in extensive bone defects. With patient's condition stabilized, the primary goal of the surgeon is bone defect repair to facilitate bone consolidation which is quite challenging.

The objective is to demonstrate successful treatment of a patient with gunshot tibia fracture complicated with purulent infection.

MATERIAL AND METHODS

A 28 year old patient M. sustained a gunshot fracture of the right tibia on October 10, 2017. The wound was debrided in emergency manner and the fracture stabilized with monolateral external fixation device (**Fig. 1**).

Wound healing was complicated with necrosis and infection treated with excision of infected tissues and repair of bone defect using antibacterial cement spacer. Epidermal defect of tibia was repaired with skin flap transfer on November 01, 2017 followed by free skin plasty with split-thickness skin graft on November 15, 2017 that resulted in the infection arrest and epidermal soft tissue recovery (**Fig. 2**).

Next stage of surgical treatment aimed at tibia defect repair was produced 7 weeks after spacer placement with the infection arrested. Skin incision was made from the approach on the anterior surface of tibia. The incision started 2 cm proximal to the spacer and proximal tibia contacting level and finished 2 cm distal to the spacer and distal tibia level. The wound exhibited hypervascularized connective tissue membrane with ossification areas of 5–10 cm in diameter at the boundary of spacer and surrounding soft tissues. The spacer was removed. Linear incision being parallel to the interosseous membrane

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was performed from the wound and fibula was exposed. Proximal fibula was osteotomized at the proximal tibia level and distal fibula was osteotomized at the end of the distal fragment. Osteotomized fragment was transferred to the tibial defect without soft tissue dissociation and adapted with tibia fragments' ends. Four-ring Ilizarov construct was used to fix tibia and the transported fibular graft. The surgery was accomplished with wound stitching and application of dressings (**Fig. 3**).

Maintaining compression at the tibiofibular interface was produced postoperatively at the rate of 1 mm every 10 days. Full weight-bearing on the operated limb was recommended to the patient after eradication of the infection and removal of sutures. Tibial bones were fixed with the frame on for 195 days (**Fig. 4**).

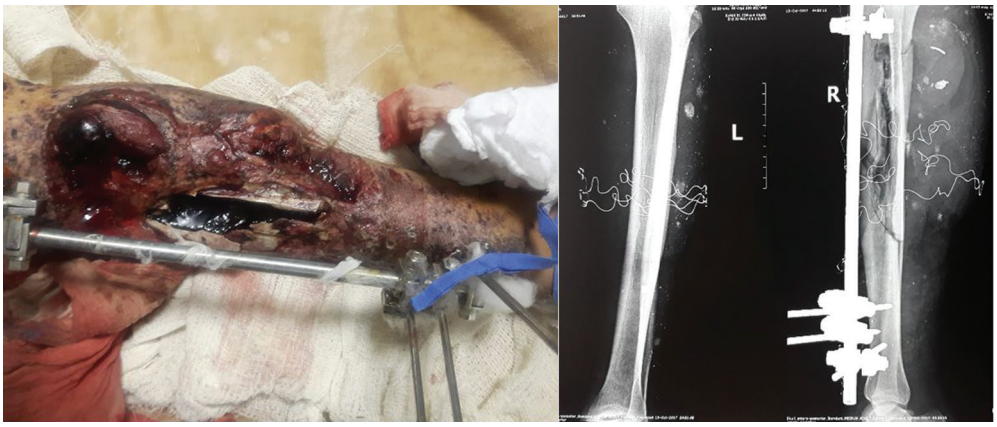

Fig. 1 Clinical appearance and radiographs of tibia of patient M. on the first day of injury

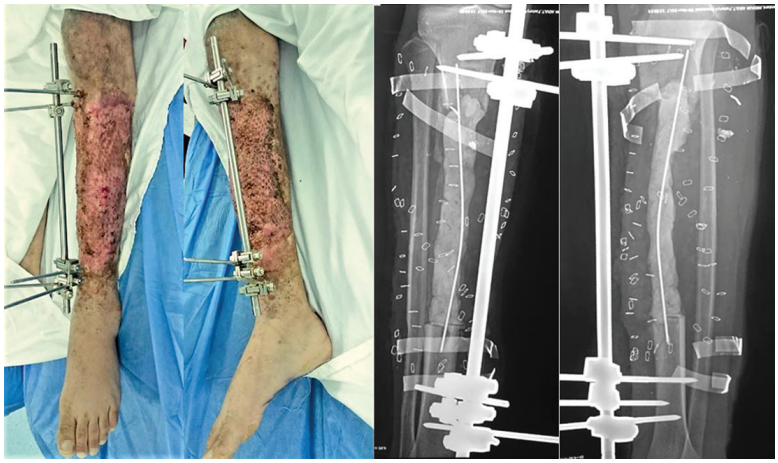

Fig. 2 Clinical appearance and radiographs of the right tibia of patient M. following debridement, spacer placement and skin grafting

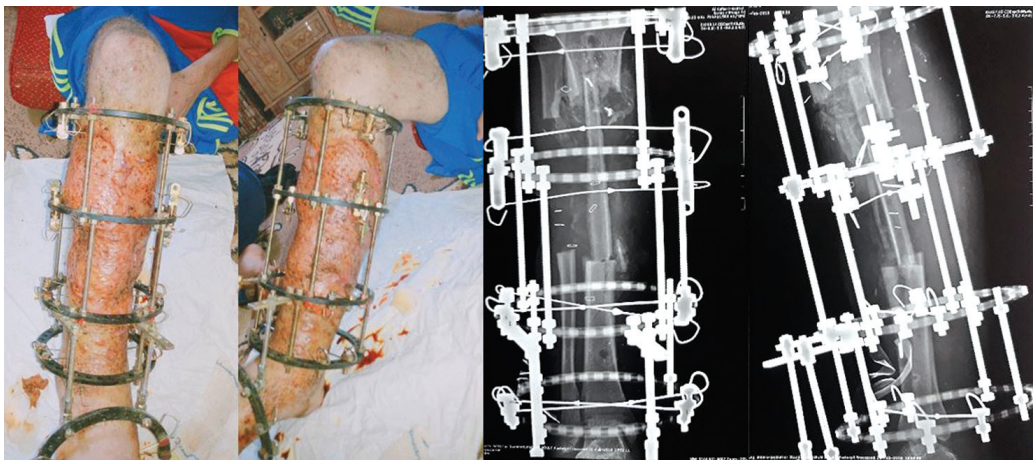

Fig. 3 Postoperative clinical appearance and radiographs of tibia

Fig. 4 Clinical appearance and radiographs of tibia prior to frame removal

RESULTS

No pathological mobility of tibia that was left with a 4 cm limb length discrepancy was observed after frame removal. No limitation in the range of motion of the knee joint was noted. The foot was rigidly positioned in plantar flexion of 105 degrees. Circular polymeric cast was applied from the knee to the toes to prevent re-fracture. The cast was taken off after three months. The result of the treatment persisted (**Fig. 5**).

Fig. 5 Postoperative clinical appearance and radiographs of tibia at 3-month follow-up

DISCUSSION

The surgeon has to pursue several goals in staged treatment of gunshot tibia fractures complicated with purulent infection. First, infection should be arrested. Excision of infected bone and soft tissues and substitution of the cavity with antibiotic-impregnated cement spacer is an accepted and most efficient way of radical debridement [1, 2]. Bone defect can be repaired at the next stage using either allograft or autologous graft [3]. Autologous grafting includes free and non-free methods depending on the defect size. A specific non-free grafting technique involves gradual traction of osteotomized tibial fragment to be docked with opposing bone using either bifocal or polyfocal distraction-compression osteosynthesis to form one or several distractional and contacting regenerates filling in the bone defect [4, 5, 6, 7]. The use of massive avascular grafts is associated with a risk of re-infection, continuous bone restructuring and osteolysis [3]. Essential shortcomings of bone defect repair with the Ilizarov method include substantial

length of the treatment, stage-by-stage approach and subjective discomfort [12]. Masquelet membrane combined with different types of bone grafting can be an alternative to the above surgical practice for the cohort of patients [8, 9, 10, 11].

Bone defect of the patient reported was repaired with fibular graft transfer following debridement of the infected tibial fracture and maintaining compression at the docking tibia-graft sites was used to ensure stable bone fixation. The exposed and transferred fibular fragment retained ties with the interosseous membrane and posterior muscle group including *m. fibularis longus, m. fibularis brevis, m. tibialis post* and could be viewed as a vascularized bone graft [12]. Stimulation effect of maintaining compression contributed to consolidation and recovery of tibial bone frame. Osteoinductive properties of Masquelet membrane were revealed in multiple bone foci formed at the union site and the graft periphery.

CONCLUSION

We suggest that the combination of different surgical techniques stimulating regeneration provides good outcomes in treatment of infected subtotal bone defects.

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