

Reconstruction of a traumatic femoral bone defect using the extruded diaphyseal segment after autoclave sterilization

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The traumatic extrusion of bone segments is rare and occurs in high-energy traumas.^[1] Segmental bone defects smaller than 5 cm are usually reconstructed with a corticocancellous bone graft from the iliac crest^[1] and an autologous fibular graft.^[2] Autoclaved allograft may be used for reconstruction when the extruded segment is longer than 5 cm.^[3] However, complications such as nonunion, malunion, and osteomyelitis may develop in these cases.

Reconstruction with an autoclaved extruded segment can be considered advantageous due to a perfectly fitting spacer for fracture bridging and maintaining bone and soft tissue length. An *in vitro* study in rats reported that a successful replacement of extruded diaphyseal segments after autoclaving.^[4] However, there is no established protocol or consensus

ABSTRACT

Clinical management of open fractures with an extruded bone defect developed due to high-energy traumas is difficult for all orthopedic surgeons. There is no consensus which graft may be used or how to sterilize the extruded bone segments. Herein, we present an 18-year-old male who had open femur fracture with an extruded segment, after a motorcycle accident. The femoral fracture was reconstructed with the 12 cm devascularized segment which was autoclaved, and no complication developed in the long-term follow-up. In conclusion, although the autoclaving of the extruded bone yielded satisfactory results in this case, it should be noted that reimplantation of contaminated bone segments can lead to severe infections.

Keywords: Autoclaved bone, extruded bone, open fracture.

on how to sterilize extruded bone segments in the literature. In this article, we report a case with open fracture in which the extruded bone fragment was implanted after it was autoclaved.

CASE REPORT

An 18-year-old male who suffered a motorcycle accident was admitted to the emergency department. On physical examination, there were dermal abrasions on the left half of the face and left arm, as well as open fractures in the left femur and left tibia. According to the Gustilo-Anderson classification, the femur fracture was type III, and the tibia fracture was type II. Tetanus prophylaxis and antibiotic prophylaxis (first-generation cephalosporin) were administered to the patient in the emergency room.

Radiographs revealed that an approximately 12 cm femoral bone segment was extruded from the 5 cm wound at the anterior thigh (Figure 1). It was thought that a longitudinal deforming force had

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continued after the initial impact causing the distal fracture and stripping of all muscle attachments from the fragment. The extruded segment was removed from the weak and contaminated muscle tissue. In the emergency room, it was washed with povidone-iodine and then serum saline. After it was wrapped with a sterile cover, it was sent to the sterilization center to be autoclaved. The femoral bone segment was then autoclaved for 10 min at 132°C and 29 pounds per square inch pressure (0.2 mega Pascal).^[5]

The patient was brought in the operating room. After the patient's wounds were washed extensively, the femoral bone segment sterilized in the autoclave was reimplanted to the lost area and fixed with a screw. Afterward, a monolateral external fixator was applied to the patient with a floating knee injury (Figure 2).

The patient was followed as an inpatient after surgery. First-generation cephalosporin and aminoglycoside administration was continued for five days intravenously. No wound infection developed at the end of the fifth day, and a retrograde

intramedullary nail for left femur diaphyseal fracture and an antegrade intramedullary nail for left tibia diaphyseal fracture were applied. The patient was mobilized with crutches the next day. The patient, who had no wound or additional problems, was discharged on the 3rd postoperative day. An exercise program was given to strengthen the muscles around the knee.

The sutures of the patient were removed at the polyclinic control at the third week. In six weeks after the operation, the patient was recommended to walk with partial weight. The patient walked with crutches in 14 weeks with full weight and started to walk without crutches in three months after the operation. At the five-month follow-up, it was observed that the fracture was healed and functional capacity was complete.

Osteomyelitis has not developed since the five-year follow-up of the patient. At the three-year follow-up of the patient, it was observed that the fracture was over-healing (Figure 3). A written informed consent was obtained from the patient for the publication of this case report.



Figure 1. Anteroposterior and lateral radiographs of the femur fracture, showing the loss of a long bone segment.



Figure 2. Immediate postoperative femur and tibia radiographs of the monolateral external fixator for floating knee injury. Autoclaved bone segment is fixed to the proximal fragment.

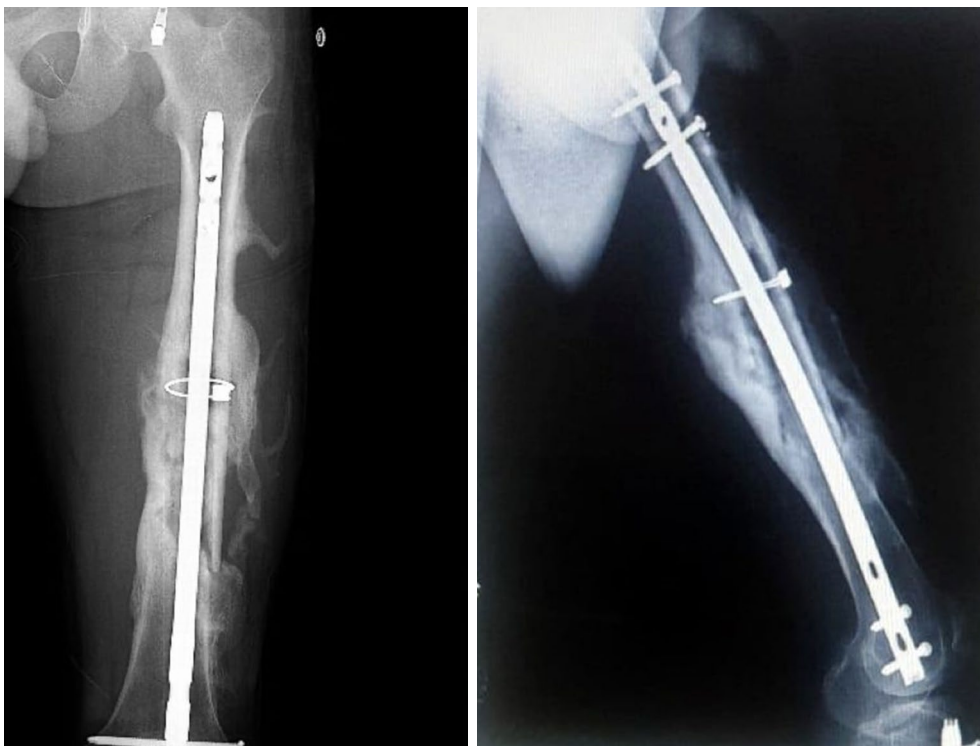


Figure 3. Anteroposterior and lateral radiographs of the femur fracture showing union.

DISCUSSION

Open fracture with extruded bone tissue manifests as a rare complication of high energy-trauma.^[1] Reconstruction of the fracture is a considerable challenge for an orthopedic surgeon aiming to provide appropriate recovery without increasing the morbidity.

When the extruded segment is short, autologous solutions such as iliac crest or fibular graft can be used. However, in the presence of a long segment loss, the extruded bone can be sterilized and reimplanted.^[6] Previous reports have described various sterilization methods, such as autoclaving before reimplantation of the contaminated

bone.^[6,7] Autoclaved autologous bone grafts are used in limb-salvage surgeries.^[8] Osteoinduction is lost by autoclaving, but osteoconduction is maintained, and incorporation at the host-graft junction is due to the periosteum of the host and forms around the autoclaved bone.^[9] There are few studies in the literature on autoclaved bone autograft replacement after traumatic extrusion. Li et al.^[4] reported a successful replacement of extruded diaphyseal segments after autoclaving. Rao and Patil^[10] reported a case of a 17-year-old male, involved in a motor vehicle accident, had a traumatic extrusion of the lower third of the diaphyseal segment of the left radius and a comminuted fracture of the distal third of the ulna. They replaced the extruded bone after autoclaving, and after follow-up, the fracture completely recovered without complications. In another study in 14 adult rabbits whose ulna was resected bilaterally, Köhler et al.^[11] compared the reimplantation of the resected bone after autoclaving with the allogeneic bone transplantation. They discovered that the autoclaved autologous bone graft was not more beneficial than the allogeneic transplant.

The defect was approximately 12 cm in our case. We had never encountered such a long extruded bone before. We chose a similar treatment method to the few studies in the literature.^[4,5] The success of our case, as with the previous cases reported, can be attributed to an intact periosteal bed and absence of infection. It is not possible to say that the over-healing in our case is related to the autoclaving of the segment, and it may be appropriate to conduct a histological examination.

In conclusion, despite the success we report herein, it should be noted that even after debridement and sterilization, reimplantation of extruded bone that has been severely contaminated can lead to devastating infections.

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