Reimplantation of a Large Extruded Segment of Bone in an Open Fracture

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Replacing an extruded segment of bone in an open fracture imposes a challenging decision concerning the best and safest patient management. There are numerous advantages to restoring the patient's own extruded bone segment to its original location, particularly when the bone segment is of structural importance. However, reimplantation of contaminated and avascular extruded bone segments can potentially result in serious infection or nonunion. There is no conclusive evidence regarding the best decontamination protocol for the safest use of the recovered bone segment as an autologous graft. Among the different chemical sterilization solutions 10% povidone-iodine and chlorhexidine gluconate solutions are the author's most preferred solutions. Regarding cellular toxicity, 10% povidone-iodine has been found to be the most favorable among the readily available solutions. *(J Hand Surg Am. 2016;■(■):■−■. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Extruded bone, open fracture, reimplantation, povidine-iodine, chlorhexidine gluconate.

OPEN FRACTURES MAY BE COMPLICATED by bone loss. Fractures with minimal bone defects may heal with stabilization alone. Small circumferential and segmental bone loss may be treated with autologous or allogenic bone grafts. Large segmental bone defects may require massive bone graft, vascularized bone graft, bone transport, or allograft for reconstruction.[1–4] If the structurally important segment of bone is retained but is heavily contaminated or extruded, or not attached by periosteum, one has to decide if one can replace that segment in its natural position.

Retrieving a large extruded bone segment from the field of an accident imposes a challenging question of whether to use the bone in its original place or discard it. The segment may be heavily contaminated in road traffic accidents, farm accidents, war-related injuries, or industrial accidents. There are some published reports regarding successful reimplantation of a large segment of extruded bone in open fractures of the femur, tibia, humerus, forearm bones, and talus.[1–23] However, there are concerns regarding the introduction of a contaminated devitalized bone fragment back into the wound, which increases the risk of infection, subsequent osteomyelitis, and nonunion. This article reviews the evidence to pose the question: what to do with a large extruded segment of bone in an open fracture regarding its safe use to preserve best function?

Table 1 demonstrates a summary of successful reports regarding the reimplantation of extruded large bone segments from open fractures. A majority of patients had been involved in road traffic accidents. Hand surgeons who treat upper limb open fractures may encounter a large extruded fragment of the upper limb skeleton. Among the 24 reports in Table 1, 6 involve the upper limbs.

Advantages of reuse of the patient's own extruded bone fragment

There are numerous advantages to reusing the patient's own extruded bone fragment in its original

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TABLE 1. Successful Reimplantation of Large Segments of Extruded Bones in Open Fractures

Authors	Age/ Gender	Site/Length	Type of Injury	Sterilization Technique	Time of Reimplantation	Storage of the Fragment
Abell, 1966[5]	26/M	Femur/19 cm	Motorcycle-vehicle accident	Soaked in benzalkonium chloride (Zephiran Chloride) and autoclaved	After 3 d	In a sterile container
Aizah et al, 2014[6]	14/M	Femur/8 cm	Motorcycle-vehicle accident	Washed with normal saline and gamma irradiated	After 2 wk	Refrigerated at 4°C
Burston et al, 2011[7]	28/F	Talus (osteoarticular)	Bicycle-vehicle accident	Washed, soaked in 10% iodine-saline solution and frozen	After 8 d	Frozen at −80°C
Canovas et al, 1999[8]	16/?	Tibia/12 cm	Cycling accident	Boiled in saline for 20 min	Immediately	-
Farrelly et al, 2012[9]	14/F	Distal tibia (osteoarticular)/ 15 cm	Pedestrian-vehicle accident	Scrubbed with chlorhexidine, rinsed with 1% povidine-iodine diluted with normal saline	Immediately	-
Hansson et al, 1977[10]	16/M	Tibia/15 cm	Motorcycle-vehicle accident	Not specified	Immediately	-
Harper, 1982[11]	31/M	Femur/9 cm	Motorcycle accident	Scrubbed with povidine-iodine and soaked in a 0.5% neomycin solution	After 65 d	Subcutaneous pouch of the opposite thigh
Kao and Comstock, 1995[12]	22/M	Radius/5 cm	Motorcycle accident	Scrubbed with povidine-iodine	After 3 d	Refrigerated at 4°C in a sterile container with bacteriostatic saline
Kirkup, 1965[13]	20/M	Femur/25 cm	Motorcycle-vehicle accident	Boiled and autoclaved before reimplantation	After 12 d	-
Kumar et al, 2006[1]	10/M	Radius/10 cm	Fell from a tree	Washed with povidine-iodine, rinsed with saline, autoclaved, and soaked in gentamicin solution	Immediately	-
Kumar et al, 2013[14]	12/F	Radius/12 cm	Fell from a tree	Brushed with Savlon, hydrogen peroxide, normal saline, and povidine-iodine and autoclaved	Immediately	-
Mnif et al, 2010[16]	34/M	Talus (osteoarticular)	Fell from a height	Cleansed for 30 minutes with 4% chlorhexidine	Immediately	-
Mazurek et al, 2003[2]	15/M	Femur/13 cm	Motorcycle-vehicle accident	Soaked in 4% chlorhexidine gluconate for a total of 270 min	After 17 d	Refrigerated in a sterile container
Meininger et al, 2010[15]	33/M	Distal tibia (osteoarticular)/ 20 cm	Motorcycle-vehicle accident	Irrigated by pulse lavage of normal saline	Immediately	-

(Continued)