Masquelet Technique for Treatment of Segmental Bone Loss in the Upper Extremity

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A relatively simple technique to address large segmental bone defects in the upper extremity is described, along with a case example. *(J Hand Surg Am. 2015;40(3):593–598. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Induced membrane, Masquelet technique, bone grafting, segmental bone defect, osteomyelitis.

CURRENT MANAGEMENT OPTIONS for reconstruction of large segmental bone defects in the upper extremity include structural bone grafting with nonvascularized autografts, vascularized autografts, allografts, distraction osteogenesis, and insertion of bioactive materials.[1–5] Nonvascularized autografts require a well-perfused recipient site for successful implantation, and there is an inherent potential for resorption with grafts longer than a few centimeters. Vascularized bone grafts have an improved rate of survival in a poorly vascularized bed; nevertheless, graft site morbidity is a potential drawback and the operation requires microvascular skills. The use of structural allografts will eliminate donor site morbidity, but can be complicated by infection, incomplete remodeling, fracture, and disease transmission.

Distraction osteogenesis involves making a corticotomy while preserving the surrounding periosteum and gradually lengthening the bone segments.[6,7] Specialized equipment is required and the transport of bone is limited to approximately one mm per day with 2–3 days of consolidation required for each day of distraction. Biological growth factors such as bone morphogenetic protein-2 and platelet-derived growth factor can stimulate the formation of mature and mechanically competent bone, although the best combinations of these signaling proteins and the ideal carrier substances for timely release remain under investigation.[8]

Autologous bone grafting within induced granulation tissue membranes, otherwise known as the Masquelet technique, is a relatively simple method of treating segmental bone defects in the upper and lower extremities.[9–20] The technique is applicable to both aseptic and septic conditions leading to substantial bone loss and requires no advanced skills in microvascular surgery. In the first stage, a thorough debridement is performed, the segmental bone defect is bridged by a tubularized construct of methylmethacrylate, and the bone is stabilized by orthopedic hardware. A thin fibrous membrane forms around the cement spacer within 4 weeks. In a second operation, the cement spacer is removed while preserving the membrane and the contained void is filled with cancellous autograft.

This grafting method is capable of addressing segmental bone defects in the limbs measuring several centimeters in length with reported union rates of 82% to 100%.[11] The majority of publications in the English and French literature pertain to use of the Masquelet technique in the treatment of segmental bone defects in the lower extremities. There are few full reports of managing bone defects in the upper extremities,[10,11,13,20] supporting our observation that this approach has not become widely used by hand surgeons. We describe the basic principles of this technique and present a case example in which an infected radial shaft fracture was effectively treated. The patient consented to have data concerning her case submitted for publication.

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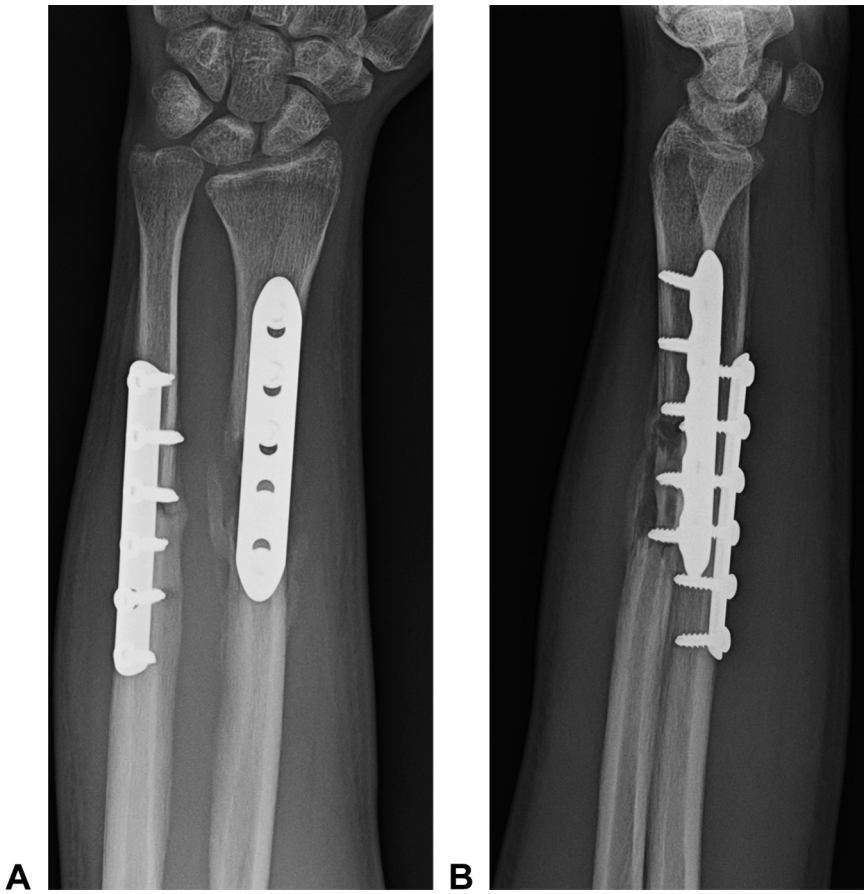

FIGURE 1: A Posteroanterior and **B** lateral radiographs of the left forearm 6 weeks after injury and repair showing loosening of both fracture fixation implants and resorption of bone in the radial shaft.

INDICATIONS AND CONTRAINDICATIONS

The Masquelet technique can be utilized in the treatment of epiphyseal, metaphyseal, or diaphyseal bone loss secondary to tumor, trauma, or infection with segmental defects measuring up to 25 cm in length.[13] The technique can also be performed in conjunction with management of soft tissue deficiencies. Poor patient compliance is an absolute contraindication to the operation. Relative contraindications include massive tissue necrosis, radiation, chronic systemic steroid use, smoking, and malnutrition, all of which which may inhibit bone healing.

SURGICAL TECHNIQUE

In the first stage, the wound is thoroughly debrided of devitalized tissue, the bone ends are freshened to bleeding tissue, and the intramedullary canals are drilled for a limited distance to promote increased vascularity. The bone is then stabilized, preferably with a plate and screws, and the void is filled with a tubularized construct of methylmethacrylate. In the event of a grossly contaminated or infected wound, or both, more than one surgical debridement and temporary stabilization of the osseous defect may be indicated before definitive fixation and insertion of a cement spacer. Impregnating methylmethacrylate with a powdered antibiotic targeted at a known or suspected pathogen may assist in sterilization of the wound. The use of a cement spacer in this fashion has been previously described and is analogous to the application of antibiotic beads in the treatment of osteomyelitis.[10,11,19]

After 4 weeks, the resultant thin fibrous membrane is incised and the cement spacer is removed en bloc or piecemeal. The rigidity of the orthopedic fixation construct is assessed and carefully augmented or revised in the event of loosening. The induced membrane is made of a type 1 collagen-heavy matrix with fibroblastic cells and contains high concentrations of growth and osteogenic factors.[11,15,17] The contained void is filled with morsellized cancellous autograft, an abundant amount of which can be obtained from the iliac crest or femoral canal, and the slit in the membrane is closed.[5,16] Cancellous allograft and demineralized bone matrix can be added as