

Open tibial bone transport following a failed bi-Masquelet procedure – a case report

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Abstract

Large bone defects are challenging to reconstruct and require specialised techniques, multiple surgeries, and long treatment periods. When these bony defects are associated with large soft tissue defects, it complicates the management further, necessitating soft tissue reconstruction in the form of local or free flaps. We report a case of a 25-year-old male, where a failed bi-Masquelet procedure resulted in a large bone and soft tissue defect of the tibia. Local or free flap reconstruction was not possible due to the extensive scarring and lack of vascular donor vessels. Open bone transport, using distraction histogenesis, was successful in reconstructing both the bone and soft tissue defects.

Key words: bone transport, bi-Masquelet, Ilizarov, bone defect, reconstruction

Background

Managing large bone defects can be challenging for any orthopaedic surgeon.¹⁻⁵ Achieving satisfactory anatomical and functional results places increased demands on both the patient and surgeon, and requires a significant investment in terms of resources and time.^{4,6,7} Most reconstructive techniques involve soft tissue reconstruction during the initial phase, which is then followed by bony reconstruction.^{1,8} This sequence of events is not always possible as extensive soft tissue damage may preclude local flaps and patent donor vessels are required for free flaps.

We report a case of successful open bone transport following a failed bi-Masquelet procedure. Soft tissue and bony reconstruction was achieved simultaneously with the use of a circular external fixator and distraction histogenesis.

Case report

A 25-year-old man was referred to our tertiary level limb reconstruction unit after a failed bi-Masquelet procedure at a referring hospital/institution. He had sustained a severe open tibia fracture (Gustilo-Anderson IIIB) with circumferential soft tissue loss one year prior to presentation.⁹⁻¹¹ His initial management included multiple debridements and monolateral external fixation. The bi-Masquelet procedure was undertaken to reconstruct an infected non-union of the left tibia. At presentation to our unit the extensively scarred soft tissue overlying the cement spacer had broken down and the wound was infected (*Figure 1*).

Soft tissue and bony reconstruction was achieved simultaneously

Local and systemic staging, according to the Cierny and Mader system, confirmed the diagnosis with stage IV B chronic osteomyelitis.¹² Host status was compromised by both systemic and local factors. These included smoking; extensive circumferential soft tissue scarring; and the fact that no donor vessels were available for free flap soft tissue reconstruction. The foot was sensate and well perfused despite only having patent peroneal and tibialis posterior arteries. Although no significant joint contractures were present, active ankle dorsiflexion was not possible due to muscle and tendon loss in the anterior compartment.

After counselling the patient about the available treatment options, including amputation, the decision to attempt limb salvage and reconstruction was made. The initial surgery involved removal of the cement spacer and debridement of all infected tissue, which resulted in a large antero-medial soft tissue defect and a 6 cm bone defect (Figures 2 and 3). Stability was maintained with the Truelok circular external fixator (Orthofix, Verona, Italy), and a transverse De Bastiani osteotomy of the proximal tibia was performed.¹³

After a latency period of 10 days, distraction was commenced at a rate of 1 mm per day through four increments of 0.25 mm. Over the ensuing eight weeks, the soft tissue defects were closed through the process of distraction histogenesis (Figure 4). Formal docking was performed at 28 weeks, once the soft tissue over the docking site was completely healed. This comprised debridement of the interposed fibrous tissue, and a cancellous onlay graft was performed via an anterolateral approach.¹⁴ A saw-tooth regenerate pattern (Ru Li type 8)¹⁵ became apparent at seven months after the corticotomy and a further 32 weeks was required for regenerate consolidation and docking site union.

The circular external fixator was removed after a total of 60 weeks. The patient has subsequently returned to his employment as an automotive mechanic. No joint contractures had developed as a result of the bone transport and he only required ankle-high boots to compensate for the loss of ankle dorsiflexion. At 2-year follow-up he has remained free of infection (Figure 5).

Discussion

Orthopaedic surgeons are frequently faced with segmental bone defects, either as a result of trauma, or secondary to debridement or tumour resection.^{1,2,5} Advances in the management of large bone defects have resulted in an increased use of limb salvage protocols in these patients.^{3,5} Where tibial defects smaller than 2 cm can be treated with simple cancellous bone grafting, defects larger than 4–5 cm will require specialised reconstructive techniques to prevent amputation.^{3,16,17}

Two of the most common techniques used to reconstruct large bone defects are bone transport according to Ilizarov principles and bone graft into an induced membrane as described by Masquelet.¹⁸⁻²¹ As bone loss is frequently associated with soft tissue defects, either as a result of the primary injury or the subsequent surgical debridement, bony reconstruction is often combined with soft tissue reconstruction.¹



Figure 1. Failed Masquelet with soft tissue breakdown over cement spacer

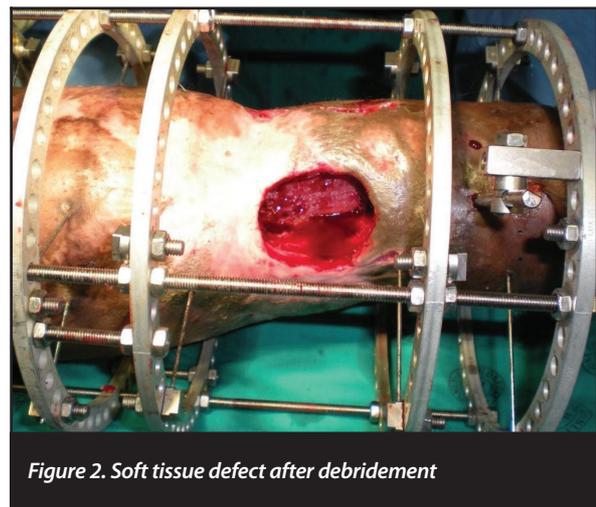


Figure 2. Soft tissue defect after debridement

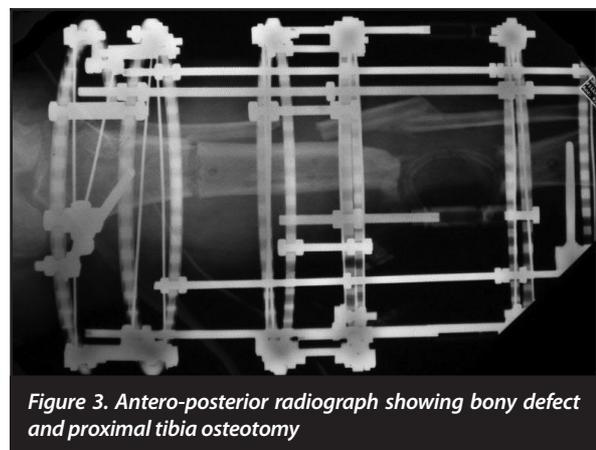


Figure 3. Antero-posterior radiograph showing bony defect and proximal tibia osteotomy

Defects larger than 4–5 cm require specialised reconstructive techniques to prevent amputation

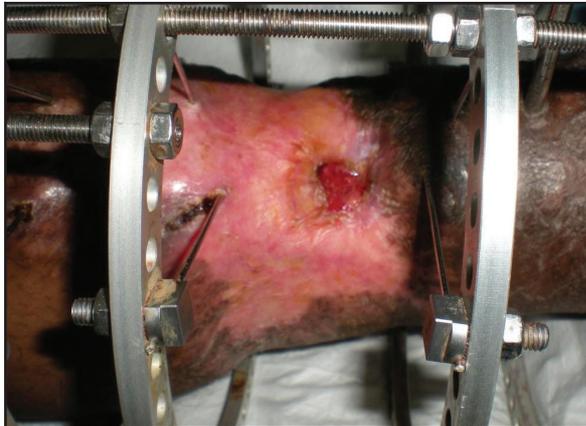


Figure 4. Soft tissue defect after eight weeks of bone transport



Figure 5. Clinical and radiological outcome after frame removal

Not only could bone continuity be restored through distraction osteogenesis but in this case gradual distraction was successful in facilitating soft tissue reconstruction through distraction histogenesis

The Ilizarov bone transport and the Masquelet bone graft techniques incorporate different philosophies/principles in order to achieve skeletal integrity. Bone transport involves creating a free segment of living bone through a corticotomy or osteotomy. This free segment of bone is gradually transported into the bone defect while regenerate bone is formed at the trailing end through the process of distraction osteogenesis. Bone continuity is restored when the transported bone segment fuses with the target bone at the docking site.¹⁶ The Masquelet procedure is performed in two stages.^{6,20,21} The first stage relies on provoking a foreign body reaction around a cement spacer left in the osseous void.²¹ This results in the formation of an induced membrane in which cancellous bone graft is packed as a second stage. The induced membrane serves as a resilient receptacle for the graft and, in addition, prevents graft resorption.^{6,20,21} It has also been found that the membrane exhibits histologic characteristics and biological properties that facilitate bone healing.²¹⁻²⁴ In the presence of soft tissue defects both these approaches, however, require soft tissue reconstruction in the form of local or free flaps during the initial phase of reconstruction.^{1,7,8,21,23,25-27}

Bone transport was chosen to reconstruct the bony defect in our patient. Not only could bone continuity be restored through distraction osteogenesis but in this case gradual distraction was successful in facilitating soft tissue reconstruction through distraction histogenesis.^{1,28,29} The soft tissue defect healed completely during the process of bone transport and no additional soft tissue procedures were required.

Bone transport is associated with multiple challenges and complications.³⁰ The most obvious challenge is the extended period of external fixation required.²⁹ Our patient required 60 weeks of external fixation in order to achieve adequate regenerate consolidation. This was probably influenced by smoking, as the saw-tooth regenerate that developed is frequently seen in smokers.¹⁵ Some of the most frequent complications of bone transport include: pin tract sepsis, failure of regenerate formation, regenerate fracture, regenerate deformity, docking site non-union, knee and ankle contractures, and recurring infection.^{30,31} Of these potential complications, only a five degree varus regenerate deformity occurred in our patient. This deformity was non-progressive and no further treatment is planned.

Conclusion

Open bone transport is a labour-intensive procedure that demands attention to detail, meticulous technique, lengthy hospitalisation and prolonged periods of external fixation. This technique should not be considered as a first option reconstruction procedure, but can be successfully employed where a bone defect is associated with an unreconstructable soft tissue defect.

Consent

Written consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

The content of this article is the sole work of the author. No benefits of any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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