Bifocal Bone Transport Using Limb Reconstruction System for Large Infected Gap Non-union of Distal Femur: A Case Report

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Abstract

Background: Large infected gap nonunion (>10 cm) following failed intramedullary nailing represent a therapeutic challenge. This case demonstrates bifocal bone transport using Limb Reconstruction System (LRS) as an effective solution.

Case Presentation: A young male presented with discharging sinus and pathological fracture 6 weeks after retrograde femoral nailing. After debridement and removal of 12 cm infected sequestrum, bifocal bone transport was performed using LRS with simultaneous proximal and distal corticotomies. Infection was controlled through debridement, antibiotic therapy, and biological advantages of distraction osteogenesis. Docking nonunion was managed by dynamization (far-far pin removal with manual compression).

Results: Patient achieved complete union with restoration of function at 18 months. Knee ROM improved from 0-80° to 0-110°.Full weight-bearing was achieved by 36 weeks. No infection recurrence or major complications.

Conclusion: Bifocal bone transport with LRS is effective for large infected gap nonunion, offering infection control, biological preservation, and accelerated consolidation with superior functional outcomes.

Keywords: Bifocal bone transport, Limb Reconstruction System, Infected nonunion, Gap nonunion, Femoral shaft, Distraction osteogenesis

Introduction

Distal femoral shaft fractures constitute approximately 4–7% of all femoral fractures, with retrograde femoral nailing being the preferred fixation method for fractures involving the distal third of the femur. Despite favourable outcomes, postoperative infection remains a serious complication, occurring in 1–3% of closed injuries and up to 33% of open fractures [1]. Established infection following intramedullary fixation can result in pathological fracture, implant failure, and large segmental bone defects that exceed the limits of conventional reconstructive techniques such as internal fixation with bone grafting or the Masquelet technique [2].

Distraction osteogenesis has transformed the management of infected non-union by enabling eradication of infection while simultaneously achieving biological reconstruction through preservation of local vascularity [3]. Bifocal bone transport, involving two corticotomies with simultaneous distraction, has been shown to significantly reduce treatment duration in defects exceeding 10 cm when compared with unifocal transport [4]. The Limb Reconstruction System (LRS), a unilateral rail fixator, offers precise control of distraction with advantages of ease of application, patient comfort, and early joint mobilization [5]. We report a case of a 12 cm infected gap non-union of the distal femur successfully managed with bifocal bone transport using LRS, highlighting docking site management through dynamization.

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Case Report

A 40-year-old male manual labourer presented with progressive pain, swelling around the distal femur, discharging sinus over the anterior aspect, and inability to bear weight six weeks following retrograde femoral nailing performed elsewhere. The patient was initially asymptomatic postoperatively but subsequently developed dull aching pain with purulent discharge from the surgical site and worsening functional limitation. Clinical examination revealed tenderness, swelling, and induration over the distal femur with an active sinus. Knee range of motion was restricted to 0–80 degrees and painful beyond this range. Distal neurovascular status was intact.

Laboratory investigations demonstrated leucocytosis with a total leukocyte count of 14,200/mm^3, elevated C-reactive protein of 18.5 mg/L, and erythrocyte sedimentation rate of 52 mm/h. Wound swab culture isolated methicillin-sensitive Staphylococcus aureus. Plain radiographs revealed a pathological fracture at the femoral midshaft just distal to the nail tip with periosteal reaction and bone resorption (Fig. 1). Computed tomography with three-dimensional reconstruction confirmed extensive periosteal reaction and comminution without vascular compromise. Magnetic resonance imaging showed marrow edema and inflammatory changes around the nail on T2-weighted sequences, with no evidence of deep vein thrombosis.

Surgical management was planned as a staged

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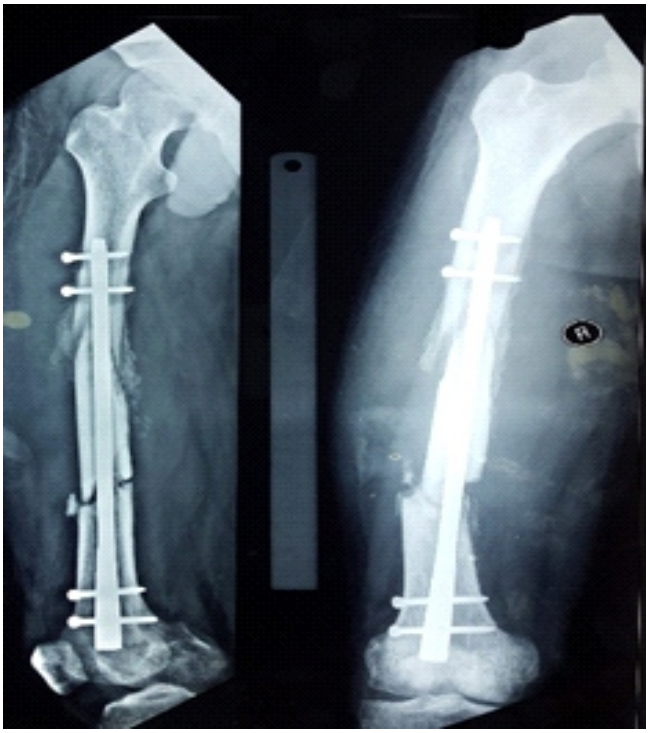

Figure 1: Preop X-ray showing Peri-implant fracture with periosteal reaction

Figure 2a: Removed Sequestrum of 12 cm

procedure. The first stage was performed under spinal anaesthesia via a longitudinal anterolateral approach. Thorough debridement and complete sequestrectomy were carried out, resulting in excision of approximately 12 cm of infected diaphyseal bone (Fig. 2a) until healthy bleeding bone margins were obtained, confirmed by the paprika sign. Multiple deep tissue samples were obtained for microbiological analysis. A limb reconstruction system was applied in a monolateral configuration using near–far pin placement to achieve four-point proximal and distal stability with 6-mm half-pins, and frame alignment was confirmed fluoroscopically (Fig. 2b). An antibiotic-impregnated calcium carrier (Stimulan®) was applied locally to the exposed bone surfaces and infected cavity.

Figure 2b: Post-op X-ray showing large Diaphyseal bone gap

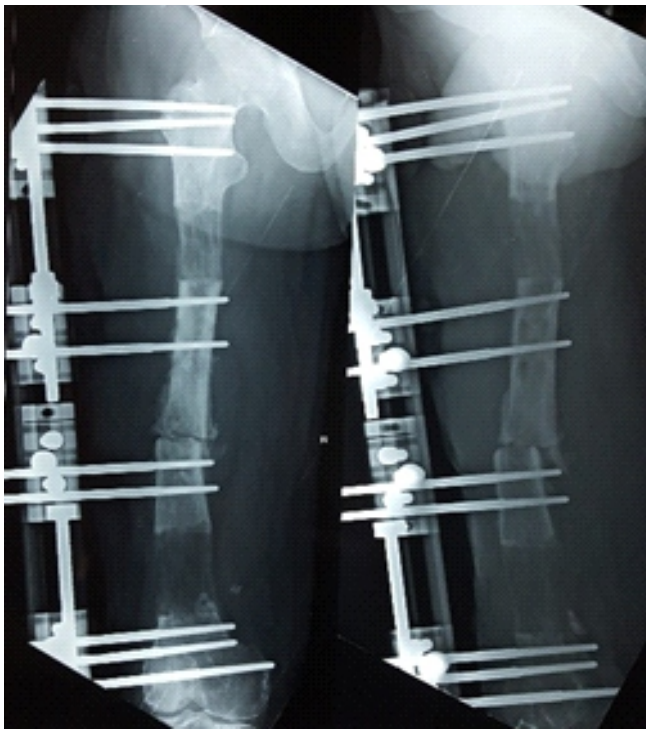

Figure 3: Bony consolidation with Bifocal focal bone transport

The second stage involved bifocal bone transport for reconstruction of the segmental defect. Corticotomies were performed at the proximal and distal metaphyseal–diaphyseal junctions, each located approximately 8 cm from the defect margins, with complete cortical disruption and preservation of the periosteum under fluoroscopic guidance. After a latency period of seven days, bidirectional distraction was initiated at a total rate of 1 mm per day, divided equally between the two corticotomy sites (Fig. 3). Distraction was continued for 12 weeks, achieving 6 cm of transport from each site and complete closure of the 12 cm defect. During the distraction phase, the patient underwent weekly pin-site assessments, radiographic evaluation every two to three weeks, and serial monitoring of inflammatory markers to assess infection control.

Wound drainage ceased by the third postoperative week, and the sinus healed completely by week four. C-reactive protein and erythrocyte sedimentation rate normalized by weeks six and ten, respectively, with no recurrence of infection at final follow-up. Radiographs demonstrated progressive bony consolidation at both corticotomy sites. At week 20, persistent lucency at the docking site suggested docking non-union. Dynamization was performed at week 24 by selective removal of far-far pins with manual compression (Fig. 4), resulting in complete union within eight weeks without the need for secondary bone grafting (Fig. 5). Full weight-bearing was achieved by 36 weeks. At 18 months follow-up, knee range of motion improved to 0–110 degrees, limb length was restored, gait was near normal, and the patient returned to modified occupational duties. Minor complications included superficial pin-site infections, which resolved with local care and oral antibiotics, and mild varus deviation corrected by frame adjustment.

Discussion

Large infected femoral gap non-unions represent a formidable reconstructive challenge, particularly following failed intramedullary fixation. In the present case, the 12 cm defect exceeded the safe limits for conventional internal fixation, bone grafting, or induced membrane techniques. Bifocal bone transport offered the advantage of accelerated defect closure while maintaining biological viability through distraction osteogenesis.

Compared with unifocal transport, bifocal transport significantly reduces treatment duration and external fixation time for large defects, while minimizing vascular compromise associated with excessive single-site distraction [4]. Peng et al. reported favourable outcomes in 76 patients treated with bifocal bone transport for infected femoral defects, with excellent or good results in 80% of cases [4]. The external fixation index in our case was 1.08 months/cm, consistent with reported favourable outcomes.

The use of a unilateral LRS provided additional advantages, including simplified application, improved patient tolerance, unrestricted knee motion due to lateral frame placement, and ease of dynamization without dismantling the construct [5]. Docking site non-union, a known complication in large defect reconstruction, was successfully managed by dynamization alone, avoiding secondary bone grafting in an infected field. Selective pin removal allowed controlled micromotion and compression, stimulating osteogenesis at the docking site, consistent with principles described by Borzunov [6].

A staged approach with initial aggressive debridement and delayed reconstruction allowed effective infection control prior to definitive reconstruction. Culture-directed antibiotic therapy administered for ten weeks aligned with established recommendations for management of infected non-union and contributed to sustained

Figure 4: Non-union gap and Compression at docking site

Figure 5: Complete Bony union with no signs of infection.

infection eradication.

Conclusion

Bifocal bone transport using a limb reconstruction system is an effective and reliable technique for managing large infected gap non-unions of the distal femur. This method facilitates infection eradication, biological defect reconstruction, and functional restoration while avoiding the morbidity associated with vascularized grafts or massive allografts. Despite prolonged external fixation, careful patient selection, meticulous surgical technique, and structured follow-up can result in excellent clinical and functional outcomes in complex femoral reconstructions.

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Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

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