The Treatment of Compound Multiple Metatarsal Fractures of Foot using the Induced Membrane Technique: Case Report

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ABSTRACT

Introduction: Bone defect is a major challenge for reconstruction. The purpose of this case report is to present a case with extensive bone defects of multiple metatarsals of the foot treated using the induced membrane technique.

Case report: A 28 year old male with compound type III b fractures of the 1st, 2nd, 3rd and 4th metatarsals with significant bone loss was treated by the induced membrane technique. At 9 months follow up after stage 2nd, radiological and clinical assessment of the foot revealed signs of osseous healing and no signs of infection. At 1 year follow up, the patient had no pain and had returned to sporting activities.

Conclusion: Successful reconstruction of bone defects is possible using the induced membrane technique.

Keywords: Induced Membrane, Metatarsal Fractures, External Fixator, Antibiotic Bone Cement.

INTRODUCTION

Bone defects whether traumatic or infective presents a major challenge for reconstruction. Several approaches have been used including the Ilizarov methodology¹, autologous bone grafting² and vascular bone grafting³. A.C Masquelet proposed a two-step procedure combining induced membrane and cancellous autografts. The first step includes radical soft tissue and bone debridement. The space created as a result of debridement is filled with antibiotic impregnated bone cement. The bone is stabilized and soft tissue envelope repaired. The 2nd stage is performed after an interval of 4-6 weeks and includes removal of bone cement and autologous cancellous bone grafting^{4,5,6}. We present a case report of multiple compound type IIIb metatarsal fractures of the foot with significant bone loss treated by the Induced membrane technique. We used external fixator and K wires to stabilize the bone and provide a strong frame construct.

CASE REPORT

A 28 year old male with no significant clinical history presented to the accident and emergency department with an alleged history of motor cycle accident. The patient's foot was caught in the spokes of a tyre. The patient was admitted in the hospital as a case of compound Gustilo- Anderson type IIIb fracture of the 1st, 2nd, 3rd and 4th metatarsals. The wound was debrided initially in the accident and emergency department and temporary stabilization of the foot was done using a below knee slab. Routine baseline investigations were done and the patient was started on intravenous antibiotics (cephazolin, amikacin and metronidazole). The patient was subsequently prepared for surgery under spinal anaesthesia.

The surgical procedure was performed in the evening of the same day. The procedure included thorough soft tissue and bone debridement. The metatarsals were stabilized using K wires and external fixators after obtaining proper alignment and length. The space created as a result of debridement was filled using antibiotic impregnated bone cement. (Figures 1, 2, 3). The soft tissue envelope was repaired. The construct was kept for a period of 5 weeks.

After 5 weeks of the baseline procedure the patient was readmitted. All baseline investigations were done. The presence of infection was ruled out clinically (no evidence of pus/ discharge, pain, fever swelling, erythema) and serologically (normal TLC, ESR, CRP). The metatarsals were approached through the initial laceration. The membrane induced around the cement was carefully incised, bone cement was removed and the space was filled with autologous cancellous bone grafting obtained from the iliac crest. The membrane was then carefully sutured back. The fixator was left in situ. The patient was subsequently discharged with instructions for guarded weight bearing. After a period of 6 weeks the fixator were removed and gradual weight bearing as tolerated was initiated. At 9 months post stage 2 of the procedure, radiographic and functional assessment was done. The soft tissue had healed completely and fracture was found united with good bone stock (Figures 4, 5). Final follow up was done at 1 year post stage 2^{nd} of the procedure. The fracture was found united. The patient had returned to active sports and resumed all activities of daily living (Figure 6).

DISCUSSION

The management of bone defects is a challenge for the surgeon. Several approaches are used in bone reconstruction. All share a common objective to regenerate lost bone and restore function. These include the Ilizarov methodology¹,

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Figure-1: Post Operative clinical picture after stage 1



Figure-2: Initial radiograph at presentation



Figure-3: Post operative radiograph after stage 1



Figure-4: Radiograph at 9 months follow up



Figure-5: Clinical picture at 1 year follow up



Figure-6: Radiograph at 1 year follow up

autologous bone grafting², vascular bone grafting³ and osteocutaneous bone grafting7. The Ilizarov methodology is one of the most commonly used techniques to bridge the gap. However, it is technically demanding and time consuming besides being fraught with problems like pin tract infection, psychological problems and non union. Autologous bone grafting alone is not recommended if the defect exceeds 5 cm because of the risk of resorption. The bone grafting methods in an infected environment are not recommended, and vascular and osteocutaneous bone grafts are associated with significant donor site morbidity and are dependent on the presence of a vascular environment at the defect site. A.C Masquelet introduced a two staged procedure for treatment of post traumatic bone defects in 1986. He used the technique to bridge diaphyseal defects upto 25 cms. In this technique a polymethyl methacrylate cement spacer induces the formation of a membrane creating a biological chamber for subsequent bone grafting^{4,5,6}. Experimental work has indicated that the induction membrane is not inert. It is a living tissue that plays an important role in bone healing or union. It has been shown that the induced membrane becomes highly vascularised and secretes a combination of important growth factors such as VEGF, TGF beta 1 and BMP 2. Furthermore, extracts from the membrane have been shown to stimulate bone marrow proliferation and differentiation of progenitor cells to osteoblast lineage. The membrane also serves a very critical function of protection of cancellous bone graft from the body's immune system thus preventing

cancellous bone resorption. Another important role of the cement spacer is that it obviates fibrous tissue invasion of the recipient site^{8,9,10}.

In our patient we used commercially available antibiotic impregnated bone cement. This was done because of the initial compound nature of the fracture and was aimed to prevent the development of infection.

CONCLUSION

Results of the technique have been good, however long term results of the technique including the nature of the bone laid are yet to be known. The technique provides an effective alternative to the traditional methods of dealing with non-union including the Ilizarov methodology, primary autologous bone grating and vascular bone grafting.

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