Bone defects greater than 6cm in the lower extremity: Is the induced membrane technique associated with favourable outcomes?

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INTRODUCTION: Bone defects exceeding 2–2.5 times the diameter of the affected bone are considered critical and challenging to manage. Twenty years ago, the induced membrane (Masquelet) technique was introduced as another option for the management of bone defects and since then several reports have been published reporting on its effectiveness and associated complications and limitations. Reports focusing on bone defects that are 6 cms or more remain scarce. The aim of this study therefore was to report on the outcomes, complications and re-intervention rates of patients treated in our institution with the Masquelet technique for bone defects of the lower extremity equal to or greater than 6 cm.

METHODS:

Between March 2015 to March 2021, all consecutive patients who presented in our unit with bone defects of either the femur or the tibia as a result of traumatic injury or developed bone loss as a result of infection requiring radical bone debridement were eligible to participate. Inclusion criteria were acute fracture with bone loss, septic non-union and chronic osteomyelitis associated with bone loss secondary to radical bone debridement. Exclusion criteria were patients with pathological fracture resulting in bone loss, bone defect loss less than 6cm, defects in other anatomical sites than the femur/tibia, or patients treated with another surgical technique (i.e. bone transport). Prospective data documented included patient demographics, mechanism of injury, type of injury and presence of associated injuries; open or closed injury, anatomical region involved, type of surgery, time elapsed between the 2 stages of the technique, graft material implanted, type of pathogen isolated in the cases where infection was the causative factor, functional status of the affected extremity, re-interventions and complications. All patients were managed according to the protocol designed by the senior author. In infected cases, broad spectrum antibiotics were prescribed after obtaining tissue samples at the time of debridement. All infected patients were treated systemically with a course of antibiotics based on the local microbiology tissue sensitivities for a minimum period of 6 weeks and were discontinued only after the haematological biomarkers were normalised. Duration of the antibiotics was dependent on the patients systemic and local wound response. Post-operatively all patients received thromboprophylaxis (low molecular weight heparin subcutaneously (Tinzaparin 4.500 IU)) for 6 weeks. Patients mobilized toe touch weight bearing initially using either a zimmer frame or crutches for 6–8 weeks and thereafter progressed from partial to full weight bearing. Outpatient follow-up with both clinical and radiographic assessment was carried out at 2 weeks for wound inspection and at 6 weeks, followed by 3, 5, 6, 9, 12 months or until radiological signs of union and pain free mobilization. Radiologically union was defined when callus formation (bridging) was present in 3 out of 4 cortices. This study was approved by the institutional review board. The minimum follow-up period was 12 months.

RESULTS: 37 patients (24 males) with a mean age of 38.3 (range 22-80 years) met the inclusion criteria. Eighteen patients had suffered a tibial defect, mean length of defect 7.7 cm (range 6-13 cm) whereas the rest, 19 patients, a femoral defect of a mean length 8.1 cm (range 6-14). 12 cases were infected non-unions while the rest of the cases were acute bone loss following open fractures. Initially external fixator was applied in 10 cases with the fixation revised during the second stage to either IM nailing of plating. The mean time from the first stage to the second stage was 9 weeks (range 8-14). After the second stage there were two failures of fixation, one Ilizarov for tibia and the other one a distal femoral locking plate that required revision. Two cases during the second stage required returning to first stage of the technique due to a compromised induced membrane macroscopic appearance consistent with residual infection, which was proven afterwards by tissue cultures. The most common microorganisms grown from the infected cases were staphylcoccous aureus and coagulase negative staphylococcous. One case (open tibial fracture) after the first stage, due to flap failure was converted to Ilizarov with acute shortening and subsequent bone transport. All the rest of the cases (36 in total) during the second stage were grafted with RIA graft which was augmented with bone marrow aspirate and platelet rich plasma (PRP) or BMP-2. One patient required re-grafting due to failure of healing in the proximal femoral defect side. The mean time to radiological union of the 36 cases was 7.4 months (range 6-12). The average time of healing of 1 cm bone defect was 1.2 months. There were 2 cases of leg length discrepancy (1 femur – 2cm; 1 tibia 1.5 cm). All patients regained a full functional capacity without residual pain during the last follow up.

DISCUSSION AND CONCLUSION:

The induced membrane technique appears to be another safe option for the management of bone defects 6cm or greater of the lower extremity secondary to acute bone loss or infected non-unions. The incidence of re-interventions was low. When infection is suspected during the second stage, debridement of the membrane and bone from the edges of the defect and returning to stage one appears to be a harmless procedure facilitating bone repair in this challenging cohort of

patients. Augmenting the RIA graft with concentrated bone marrow aspirate and a growth factor seems to enhance the local healing response. Following a standardised protocol reduces the risk of reinnervations and improved outcomes as seen in this group of patients.