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Management of Segmental Bone Defects Using Masquelet Technique

Somnath De*, Nikhilesh Das*, Sudipto Mukherjee*, Sabyasachi Bardhan*

Author's Affiliation: *Clinical Director, **Consultant, ***Assistnat Consultant, ****Associate Consultant, Department of orthopaedics and trauma, Peerless Hospital and B.K. Roy Research Centre, Kolkata, West Bengal.

Corresponding Author: Somnath De, Clinical Director, Department of Orthopaedics and Trauma Peerless Hospital & B.K. Roy Research Center 360 Panchasayar, Kolkata - 700 094 West Bengal.
E-mail: drbardhan13@yahoo.co.in

Abstract

Background: Surgical reconstruction of segmental skeletal defects represents a true challenge for the orthopaedic surgeons. Masquelet et al described a two stage technique for reconstruction of bone defects known as induced membrane technique in the management of segmental skeletal defects resulting from traumatic bone loss, osteomyelitis. *Materials and Methods:* Eight patients with segmental bone defects were treated in our hospital by induced membrane technique. The mean age of patients was 36 years (age range18 – 55 years). The causes of the defects were traumatic bone loss in 4 patients and chronic osteomyelitis in 4 patients. The defects were located in femur (n=3), tibia (n=3), humerus (n=1), radius shaft (n=1). The defect ranges were from 3 – 9 cms. All cases were treated by induced membrane technique in two stages. *Results:* Bone union happened in all patients. Duration of keeping cement spacer was 6 – 8 weeks. Five out of 8 cases required second episode of bone grafting. *Conclusion:* The induced membrane technique is a valid option for the management of segmental defects if done judiciously but the time required for growth and maturation of graft is relatively long.

Keywords: Induced Membrane; Osteomyelitis; Bone Defects; Cement Spacer; Post Traumatic**.**

Introduction

Large segmental bone gaps in a long bone poses a challenge to the treating Orthopedician. These gaps may be a result of traumatic bone loss, osteomyelitis or tumor excision. These gaps can be bridged by bone transport, vascularised graft, bone grafting and rhBMP. Usually large gaps have been traditionally treated with internal bone transport after corticotomy using Ilizarov or a linear external fixator. The use of Vascularised fibular graft lacks popularity due to a lack of logistics and lack of proper recipient vessel in the diseased limb. We are presenting a series of 8 cases where bone defects larger than 3 cm was addressed using Masquelet technique.

Patients & Methods

9 patients are included in this series, admitted between 2012 to 2015 in Peerless Hospitals. 4 patients presented with traumatic bone loss and 5 patients with chronic osteomyelitis (all of them post surgical). The patients were evaluated for location of defect, size of defect, soft tissue condition, Type of antibiotic in spacer, Duration of use of spacer, Definitive fixation method and current status (Table 1).

Surgical Technique

After proper evaluation the patients are taken up for surgery. In some cases the unaffected limb is draped free to assess the length alignment and rotation. In post traumatic cases wound is thoroughly lavaged with 9 litres of Normal saline and the wound is thoroughly debrided. All foreign bodies, devitalized tissue and bone fragments with no soft tissue attachment were removed. We use fluoroscopy guidance to locate and clean out radio opaque debris. In cases with chronic osteomyelitis, we remove any implants (if not already removed), excise the sinus,

perform radical debridement. Thereafter we concentrate on providing stability maintaining proper length alignment and rotation. We mostly use a linear external fixator for this purpose. Though in one post traumatic case we went for definitive fixation during the stage of debridement. Now we address the bone defect with a PMMA cement spacer. We use 40 grams of PMMA mixed with 2 grams of Vancomycin ; then the spacer is shaped and sized according to the defect in the dough stage. In the second stage, we incise the pseudo membrane to remove the spacer, go for definitive fixation in some cases and fill the gap with copious amount of cortico cancellous bone graft. Some cases needed a second bone graft as well.

Serial No.	Age/ Sex	Bone	Indication	Size of defect	Soft tissue	Definitive fixation	Duration of cementation	Number of bone grafting
1	23/M	Tibia	Gustillo IIIA	5cm	Contaminated	Interlocking nail	8 weeks	2
2	22/M	Radius	Chronic Osteomyelitis with Implant in situ	4cm	Discharging sinus Scarred tissue	Small LCDCP	8 weeks	1
3	38/M	Femur	Gustillo IIIA	4.5 cm	Contaminated	DFLCP	6 weeks	2
4	42/M	Humerus	Chronic Osteomyelitis with nail in situ	3cm	Discharging sinus	Narrow LCDCP	6 weeks	1
5	52/F	Tibia	Chronic Osteomyelitis (post surgical)	8 cm	Poor, scarred, Discharging sinus	Interlocking nail	8 weeks	2
6	36/M	Tibia	Gustillo II	3cm	Contaminated with skin loss	External fixator	6 weeks	1
7	20/M	Femur	Gustillo IIIA	9cm	Contaminated with necrosed skin flap	DFLCP	6 weeks	2
8	55/M	Femur	Infective nonunion with nail in situ	6.5cm	Discharging sinus	DFLCP	6 weeks	2

Results

8 cases were included in these series, 7 males and 1 female. Age of patients range from 18 years to 55 years (mean age 36 yrs). In this series 3 cases involved the femur, 3 cases the tibia, 1 case involving the humerus, and 1 case of radius shaft . Bone defects range from 3cm to 9cm. 4 cases were post traumatic open fractures (3 cases with Gustillo IIIA injury and 1 case Gustillo II injury) with bone loss. Remaining 4 cases in these series are of chronic osteomyelitis/infective non union in a post traumatic post surgical case, 3 cases with implant in situ, being referred to our hospital for further management. We have used 40gms of PMMA mixed with 2gm of Vancomycin in all our cases. The dough was then shaped and sized to fit the defect. Duration of keeping the cement spacer was 6 to 8 weeks. Definitive fixation was done with Interlocking nail in 2 cases, Plates and screws in 5 cases and External fixator in 1 case. 5 out of 8 cases required a 2nd episode of bone grafting. Bone grafts were harvested from iliac crest and tibia. We had no failures in this series.

Series 1:

Series 2:

Discussion

Segmental bone gaps in diaphyseal or metaphyseo diaphyseal area of long bones have always has been a challenge to the orthopaedic surgeon. The available methods of bridging bone gaps are distraction histogenesis after corticotomy using Ilizarov frame or a linear external fixator, Vascularised bone graft (fibula, rib etc) and corticocancellous bone grafts. Distraction histogenesis requires daily distraction by the patient (1mm/day) which in our opinion leads to improper and unequal distraction especially using an Ilizarov frame. Also there are chances of pin tract infection and mal alignment of transported fragment. Vascularised bone graft requires specialized training in microvascular surgery, specialized equipments and can be technically difficult to anastomose with the recipient vessel in the traumatized diseased limb.

French surgeon Alain-Charles Masquelet developed the two-stage technique in the 1980s, describing results of 35 patients with diaphyseal defects ranging from 4 to 25 cm [1]. Recent literature has shown that this biomembrane can be 0.5 to 1mm thick [2] and has been described as hyper-vascular and impermeable . The induced membranes were hypothesized to contain bone-stimulating factors [3]. Tan et al. found it to contain an even greater number of mesenchymal stem cells , probably the crucial factor that proved so successful in reconstruction of large bone defects with the technique [4].

In our series, after initial lavage and debridement we have use Vancomycin loaded cement spacer, shaped to fit the bone defect; the purpose was eradication or prevention of infection by allowing high dose of locally available antibiotic and obliteration of dead space. The pseudomembrane cavity hence formed was subsequently used to do bone grafting. In all but one case we have initially used an external fixator to provide stability which was later changed to IM nail (2/8 cases) or plates and screws (5/8 cases). In 1 case we continued to use external fixator as the stabilizing device. The choice of implant for definitive fixation was governed by soft tissue condition and location of bone defect. Its our opinion that implants which offer better stability should be chosen for definitive fixation. A potential effect of a construct that is too rigid may be stress shielding near the plate,

reducing integration of the bone graft near the implant. This does not preclude bony union but may increase time to osseous consolidation and affect the radiographic appearance of the defect.

The mean interval between 1st and 2nd stage of surgery was 46.6 days. The mechanism of action of induced membranes in bone repair was studied recently by Aho and his colleagues They found that the one-month-old membrane has higher osteogenesis-improving capabilities compared to two month-old membrane; they concluded that optimal time for performing second-stage surgery may be within a month after implantation of foreign material [5].

In our series 5 out of 8 cases required a 2nd episode of bone grafting (done 6 weeks after first bone grafting). All these cases had a defect more than 4cm and we observed intraoperatively the necessity of more bone graft for these defects. We felt that this would not be necessary if we could avail allograft for these large defects, but the issue was financially prohibitive for the patients.

Conclusion

Masquelet technique is an excellent modality to address segmental bone defects. Potentially infected open fractures and cases of chronic osteomyelitis can be managed with antibiotic laden cement spacer, which serve the dual purpose of infection control and pseudomembrane formation. Using the most stable form of definitive fixation produces good results. The necessity of allograft was felt during managing cases with large defects, hence repeat grafting was required

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