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## Masquelet technique for treatment of open tibia fracture with bone loss: An observational study

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### Abstract

**Background:** Post-traumatic segmental bone loss with open tibial fracture is a clinical problem with a significant long term morbidity. Reconstruction of this defect is a major challenge in orthopaedic practice. In 1986, the French technique of autologous bone grafting within induced granulation tissue membrane, otherwise known as Masquelet technique, offers a suitable alternative. This study was aimed to observe clinical, radiological and functional outcome in patients with open and infected tibia fracture managed by Masquelet technique.

**Methods:** This observational prospective study was conducted MKCG Medical College & Hospital, Berhampur from June 2015 to June 2018. Patients (18 to 60 years) with compound tibial defects of size less than 5 cm with or without infection and soft tissue defect were included in study. In total 11 patients were treated with Masquelet technique i.e by induced membrane technique with an antibiotic cement spacer implant. Routine radiograph were performed and weight bearing was removed after radiographic sign of union and clinical outcome was monitored with lower limb functional index.

**Results:** Average age was 35.3 years with 1 female and 10 male patients. Radiological union was seen in all patients and average time of radiological union was 43.8 weeks. Full weight bearing was achieved after an average time of 16 weeks (ranged from 16 weeks to 21 weeks). Average follow up period was 12.3 months. Average lower limb functional index was 59% with a range of 37% to 90%.

**Conclusion:** Masquelet technique can be a good option of treatment of patients with bone defects and can be performed easily in lower trauma centres without involving other specialities as does not require specialised equipment and can be done by surgeons with varying experience and capabilities.

**Keywords:** Induced membrane technique, tibia fracture, bone defect, limb amputation, bone graft

### Introduction

Post-traumatic segmental bone loss with open tibial fracture is a clinical problem with a significant long term morbidity. Reconstruction of this defect is a major challenge in orthopaedic practice due to various factors like concomitant infection, difficult techniques, prolonged healing time and poor long term clinical outcome<sup>[1]</sup>. In the early centuries patients having compound traumatic tibial fractures with segmental bone loss were treated by limb amputation which was subsequently replaced by limb salvage techniques and other treatment options like non-vascularised auto grafts, vascularised bone grafts and allografts<sup>[2, 3]</sup>. In 1986, the French technique of autologous bone grafting within the induced granulation tissue membrane, otherwise known as Masquelet technique, offers a suitable alternative with minimal complications<sup>[4, 5]</sup>.

There are limited studies for open infected tibia fracture treated with Masquelet technique. So this study was planned to observe the clinical, radiological and functional outcome in patients with open and infected tibia fracture managed by Masquelet technique.

### Methods

This observational prospective study was conducted in the department of orthopaedics, MKCG Medical College & Hospital, Berhampur. Patients in the age group of 18 to 60 years with compound tibial defects of size less than 5 cm with or without infection and with or without soft tissue defect coming to the institution between June 2015 to June 2018 were included in the study. These patients were treated with Masquelet technique i.e by induced membrane technique with an antibiotic cement spacer implant.

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Patients with bone defects of aetiology other than trauma and patients with persistent infection even after cement spacer application were excluded from the study. In total 11 patients were observed in this study. All the patients were followed up till their union of the fractured bone. This study was performed after obtaining Institute ethical committee approval and patients informed consent prior to the surgery.

In traumatic patients who qualified for inclusion criteria were first temporarily stabilised. Soft tissues and fractures were debrided and managed temporarily. All blood investigations and microbiological cultures of wound were done and pre-operative standardised antibiotics were started. Patients with primary or secondary infection, with zone of vital bone and with complete soft tissue coverage were treated with Masquelet technique.

In the Masquelet procedure, bone ends were debrided and fracture was temporarily stabilized with an external fixator. The cement spacer was implanted with an overlap to the bone ends to provide a more extensive induction of the membrane. After weeks, the resultant thin fibrous membrane was incised and the cement spacer was removed. The void was filled with cancellous auto graft which was obtained from the iliac crest

or femoral canal depending upon the volume of the defect and finally the membrane was closed. Plate or an intramedullary nail was provided for definitive stability.

Post operatively the extremity was protected from load bearing by a limitation. On first post-operative followup routine radiograph were performed. Then standardized radiographs and routine clinical controls were performed after 6 weeks, 3 months, 6 months and 12 months. Weight bearing was removed after radiographic sign of union occurred. Radiographic union was defined as bridging bone on a minimum of 3 cortices in antero-posterior and lateral radiographic view [6]. The clinical outcome was monitored with lower limb functional index till the last outpatient consultation.

## Results

### Patients characteristics

In this observational study total 11 patients with open tibial fractures were treated with Masquelet technique and followed up till union of fractured bone. The clinical profile of patients were depicted in the table number 1.

**Table 1:** Clinical profile of patients in the study (n = 11)

Patient number	Age (in years)	Sex	Mode of injury	Grade of injury	Size of bone defect
1	42	M	RTA	IIIa	4.5 cm
2	21	M	FFH	IIIb	2 cm
3	47	M	RTA	IIIb	2.3 cm
4	33	M	FFH	IIIa	3.4 cm
5	32	M	RTA	IIIb	3.2 cm
6	50	M	RTA	IIIb	4.6 cm
7	19	M	FFH	IIIb	2.9 cm
8	28	M	RTA	IIIb	2.2 cm
9	38	F	RTA	IIIa	2.7 cm
10	41	M	FFH	IIIb	3.1 cm
11	37	M	RTA	IIIa	4.7 cm
Average/total	35.3	M= 10, F=1	RTA= 7, FFH= 4	IIIa= 4, IIIb= 7	3.23 cm

RTA= Road traffic accident, FFH= fall from height

The mode of injury was road traffic accident in 7 patients and fall from height in 4 patients. Out of 11 patients, 10 were male and only one was female. The average age was 35.3 years with a range of 19 years to 50 years. Out of 11 cases, 7 cases of grade IIIb compound injuries and 4 cases of Grade IIIa compound injuries. The size of bone defect ranged from 2 to 5 cm.

### Outcome characteristics of patients after Masquelet procedure

The cement spacer was implanted for an average period of 14 weeks (ranged from 9 weeks to 28 weeks). Table 2 showed the result or outcome of patients after Masquelet procedure.

**Table 2:** Outcome of patients after Masquelet procedure (n = 11)

Patient number	Radiological Union	Time to radiological union	Time to full weight bearing	Follow up period
1	Yes	45 weeks	16 weeks	13 months
2	Yes	30 weeks	12 weeks	10 months
3	Yes	51 weeks	17 weeks	14 months
4	Yes	26 weeks	12 weeks	8.5 months
5	Yes	52 weeks	17 weeks	13.5 months
6	Yes	38 weeks	15 weeks	10.2 months
7	Yes	42 weeks	16 weeks	11.3 months
8	Yes	60 weeks	21 weeks	15.8 months
9	Yes	30 weeks	13 weeks	10 months
10	Yes	49 weeks	17 weeks	13.3 months
11	Yes	59 weeks	20 weeks	15.5 months
Average/total	Yes= 11	43.8 weeks	16 weeks	12.3 months

Radiological union was seen in all patients and the average time of radiological union 43.8 weeks. Range of time to radiological union was from 26 weeks to 60 weeks. Full weight bearing was achieved after an average time of 16 weeks

(ranged from 16 weeks to 21 weeks). Average follow up period was 12.3 months (range 8.5 months to – 15.8 months). Average lower limb functional index was 59% with a range of 37% to 90%.

Radio graphical images of right tibia of a 41 year old male Patient from the day of surgery upto bone union were shown in figure number 1. Segmental bone defect was filled with cement spacer and stabilized with a plaster cast. (1-2). after days cement spacer was removed and cancellous autografts were placed within induced membrane and tibia was stabilized with external fixator (3-4). The follow up radiograph showed union of bone (5-6).



**Fig 1:** Radiographical images of right tibia of a 41 years old male patient from day of surgery upto bone union.

### Discussion

Management of bone defects with an infection gathers a great attention by clinical community. There are various techniques for the treatment of compound tibial fractures with bone loss like circular ring fixators and limb reconstruction system using the distraction Osteogenesis but this requires specialized training [7]. Some authors have used vascularised fibula graft for large bone defects with varying results limited by pedicle length which involves microsurgical anastomosis [8]. Recently the induced membrane is a relatively newer method described by Masquelet *et al.* which is a two- staged technique for reconstruction of bone defect [3, 4]. It is a simple and straight forward procedure with good results [9-11].

Masquelet technique involves induction of membrane at bone ends. This membrane (Pseud Periosteum) possesses a rich capillary network and enriched with growth factors (VEGF and TGF beta-1) and Osteoinductive factors (BMP -2) as described by Pelissier *et al.* [5]. Viateau *et al.* conducted immunohistochemical studies on induced membranes in a sheep model by and established the presence of cells expressing transcription factor CBFA1, and type-1 collagen rich extracellular matrix [12]. The membrane formed acts as a barrier to outward diffusion of growth and Osteoinductive factors, prevents resorption of bone graft and provide a source of Osteoprogenitor cells and vascular cells supporting revascularization and osseous consolidation [4].

In our study we described 11 patients with open tibial fracture treated by Masquelet technique. Radiological union was seen in all patients and the average time of radiological union 43.8 weeks. Full weight bearing was achieved after a average time of 16 weeks. Average lower limb functional index was 59% with a range of 37% to 90%.

Muhlhauser *et al.* in their study in 8 patients, found that except one patient all show radiological union in a median time of 52 weeks. Full weight bearing was achieved with a median time of 16 weeks and median lower limb functional index was 60% [12].

Similarly Gupta *et al.* in their study in 9 patients observed that Serial Radiographs showed regular uptake of auto graft. Bone-union was documented in all patients and all patients are walking full weight-bearing without support [13]. Aparad *et al.* in their study in 12 patients found that complete weight-bearing was resumed at a mean of 4 months [14]. Karger *et al.*

in their study in 84 patients found out that union was obtained in 90% of cases with a mean of 14.4 months. 10% failures involved severe leg trauma associating extensive bone defects, soft tissue lesions and infection and required amputation in 6 cases [15].

However Morris *et al.* in their study in 12 patients got mixed result as bony union was achieved in 5 patients, 5 patients experienced infective complications during treatment and 2 required amputation because of severe infection [16].

This observational study included small sample size which could be a limitation for this study. However it provides a platform for further large study.

### Conclusion

The Masquelet technique i.e. induced membrane technique can be a good option of treatment of patients with bone defects with or without soft tissue defects. However this method of treatment requires long consolidation time and prolonged non-weight bearing compared to other treatment options. This technique can be performed easily in lower trauma centres without involving other specialities as does not require specialised equipment and can be done by surgeons with varying experience and capabilities.

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