

# Comparative study of primary internal fixation of open peri-articular fractures around knee with and without antibiotic impregnated polymethylmethacrylate beads.

<sup>1</sup>Dr Debojyoti Mukherjee, <sup>2</sup>Dr. Niladri Biswas.

<sup>1</sup>Associate Professor, Department of Orthopaedics, R g kar Medical College, Kolkata

<sup>2</sup>Senior Resident, Department of Orthopaedics, R g kar Medical College, Kolkata

## Correspondence Author.

Dr Debojyoti Mukherjee

Associate Professor

Department of Orthopaedics

R g kar Medical College, Kolkata

## Abstract

### Introduction

In the modern era of fast living there is increased incidence of road traffic accidents. As these accidents are high velocity trauma they are frequently associated with open injury. The knee joint is vulnerable to get injured in motor vehicle collision. These open peri-articular fractures pose great economical burden on our society and mental, social and financial burden upon the patient. Although systemic antibiotics have been used for many years, newer method of local antibiotic delivery system has come up in the form of antibiotic impregnated cement beads which increases local antibiotic level, decreases systemic toxicity and possibly has greater efficacy.

### MATERIAL AND METHODS

This is a Prospective and comparative study conducted in the Department of Orthopaedics. R G Kar Medical College & Hospital, Kolkata. Patient attending emergency department and OPD of R G KAR Medical College with open peri-articular fracture around knee. A total of 43 cases attending either outdoor or emergency or being referred from peripheral hospitals, were selected on the basis of inclusion criteria, 3 of which were lost during follow up. Ultimately 40 patients were evaluated in this study

### RESULTS

In our study population 32 patents were male and it comprises 80% of the study population. The age distribution shows it was more common in middle age group (below 40 years) and consists of 52.5% of study population. Study also showed right sided involvement was 65% and 60% for respective groups. Of the patients 60% and 55% had Gustillo Anderson's open type IIIA fractures. Primary wound closure could not be done after optimum debridement for 15% of patients in both groups. Thus it was very clearly visible from our study that antibiotic PMMA beads had significant role in controlling infection in open fractures.

### Conclusion

Open fractures were always a challenge for orthopaedic surgeons. Treatment strategies revolutionized from early emergency amputation in pre-antibiotic era to limb saving surgeries

with combined effort of orthopaedicians, plastic surgeons and vascular surgeons. With innovation of highly potent antibiotic newer method of drug delivery system also comes forward with promising results. So, from the above results we conclude that primary internal fixation for open peri-articular fractures around knee yielded better results when PMMA beads were added. However internal fixation should be attempted only when debridement is adequate and the wound is ready for coverage.

**Keywords:** Primary internal fixation, Peri-articular fractures, Antibiotic impregnated polymethylmethacrylate beads

### Introduction

In the modern era of fast living there is increased incidence of road traffic accidents. As these accidents are high velocity trauma they are frequently associated with open injury. The knee joint is vulnerable to get injured in motor vehicle collision. These open peri-articular fractures pose great economical burden on our society and mental, social and financial burden upon the patient.<sup>1</sup>

Traditionally the treatment strategy has been early parenteral antibiotics, saline lavage, thorough wound debridement, tetanus prophylaxis, bone fixation either by external fixator or by internal fixator, control of infection and gaining painless functional range of motion. Several studies has shown that mean rates of infection have ranged from 0% to 2% for Gustillo Anderson's type I open fractures, from 2% to 5% for type II, from 5% to 10% for type IIIA, from 10% to 50% for type IIIB, and from 25% to 50% for type IIIC.<sup>2</sup>

In periarticular fractures it is preferable to fix the fractures with internal fixation device over the external fixator as the latter is associated with pin tract infection, pin tract loosening, pin breakage, joint stiffness, loss of reduction and ultimately poor functional outcome. Internal fixator is associated with better fracture stabilization, early joint mobilisation and early weight bearing. However internal fixator as well as the bone should have proper soft tissue coverage for the viability of the bone. This is sometime difficult with open fracture as full coverage may sometime create an environment for microbial colonization and growth.<sup>3</sup>

Although systemic antibiotics have been used for many years, newer method of local antibiotic delivery system has come up in the form of antibiotic impregnated cement beads which increases local antibiotic level, decreases systemic toxicity and possibly has greater efficacy.<sup>4</sup>

It delivers locally higher level of antibiotics in that much concentrations which exceeds the minimal inhibitory concentrations. Pharmacokinetic studies have shown that the local concentrations of antibiotic achieved are 200 times higher than levels achieved with systemic antibiotic administration. This has the advantage of obtaining very high local antibiotic concentrations, while maintaining low serum levels and low systemic toxicity.<sup>5</sup>

The antibiotic diffuses from the PMMA (polymethylmethacrylate) beads into the postoperative wound hematoma and secretion, which act as a transport medium. High concentrations of the antibiotic can be achieved only with primary wound closure; if such closure cannot be performed, the wound can be covered with a water-impermeable dressing (Antibiotic Bead Pouch technique). Suction drains are not recommended because the concentration level of the antibiotic is diminished when they are used.<sup>6</sup>

Using antibiotic cement beads thus creates an environment of high local concentration around the fracture site and low systemic level which helps in proper control of infection and thus promotes early fracture union, painless functional range of motion, early weight bearing.

In our study patients of open periarticular fractures around knee (i.e. distal femoral & proximal tibial fractures) were selected systematically and undergone primary internal fixation with or without antibiotic PMMA beads. At the end of study period a comparison was done in both groups to evaluate the efficacy of cement beads in treating infection, promoting union, in functional outcome of the patient and for need of any further operation.<sup>7</sup>

### **Aims and objectives**

The aim of our study was to compare the results of primary internal fixation of open peri-articular fractures around knee with and without antibiotic impregnated polymethylmethacrylate beads.

### **MATERIAL AND METHODS**

**This is a** Prospective and comparative study conducted in the Department of Orthopaedics, R G Kar Medical College & Hospital, Kolkata. Patient attending emergency department and OPD of R G KAR Medical College with open peri-articular fracture around knee.

### **INCLUSION CRITERIA**

- Open Gustillo Anderson's type IIIA, type IIIB peri-articular fractures around knee attending emergency or OPD.
- Age >12 and <65 years.
- Primary internal fixation done within 7 days of fracture.

### **EXCLUSION CRITERIA**

- Closed peri-articular fracture around knee.
- Open Gustillo Anderson's type I and type II & IIIC fractures.
- Age <12 and >65 years.
- Any open pathological fractures.
- Primary internal fixation done in >7 days.
- Patient suffering from other concomitant major visceral injuries.

## SAMPLE SIZE

A total of 43 cases attending either outdoor or emergency or being referred from peripheral hospitals, were selected on the basis of inclusion criteria, 3 of which were lost during follow up. Ultimately 40 patients were evaluated in this study.

### ➤ PARAMETERS TO BE STUDIED

#### a. Parameters of specific objective No.1

clinical examination and laboratory investigation to assess the rate of infection and to compare.

#### b. Parameters of specific objective No.2

Clinical and radiological examination to assess rate of union and to compare.

#### c. Parameters of specific objective No.3

Clinical examination to assess the range of movement, time taken for full weight bearing, Rasmussen's functional score system and Neer scoring system to compare the functional outcome.

#### d. Parameters of specific objective No.4

Clinical & Radiological examination, laboratory investigation to assess need for future operation and to compare.

## STUDY TECHNIQUE



PIC 1: OPEN WOUND IN DISTAL FEMORAL REGION  
(TYPE IIIA)

Patients attended either outdoor or emergency or being referred from peripheral hospitals were first evaluated accordingly advanced trauma life support (ATLS) guidelines. From the time of injury until the wound of the patient was ready for surgery, the wound was always protected by a sterile dressing, and the extremity was splinted to prevent additional soft-tissue injury from movement of the sharp bone fragments. Tetanus prophylaxis may be required by tetanus toxoid and tetanus immunoglobulin, depending on previous vaccinations status. Early parenteral antibiotic was started as early as possible. As the microbial organism found in road traffic accident is of mixed variety all patients were given gram positive, gram negative and anaerobic antibiotic coverage.



PIC 2: PATIENT UNDERGOING PRIMARY INTERNAL FIXATION WITH DISTAL FEMORAL LOCKING PLATE

A typical dose of 4.0 g Vancomycin was added to 40 g of PMMA. Vancomycin was used as it is enough heat stable to withstand the exothermic reaction produced during cement mixing and its broad spectrum activity against those organisms which are commonly encountered in open fracture. For making beads the mixture of antibiotic and PMMA and methylmethacrylate was molded or rolled to 3-10 mm spheres and then strung on to S-S wire no.20G/22G.

PIC 3: BONE CEMENT

### POST OPERATIVE PROTOCOL

- Intravenous antibiotics were given for first three to five days and then switched over to oral antibiotics for another ten days. Antibiotic therapy was stopped thereafter if there were no definitive indication for further continuation.
- Analgesia (other than NSAIDS) were administered as per patient's requirements.
- As soon as the patient recovered from anesthesia, liquid food was allowed and they were permitted to sit up in the bed 24 hours after surgery.

**Statistical Methods**

Categorical variables like age group, sex, side, Time of Intervention, Fracture Type, Primary Wound Closure, Cement Beads Removal, Range of Motion, Weight Bearing, Discharge, Reactive Protein, Infection, Radiological Union, Tenderness, Union, Rasmussen's Score, NEER, Further Operation and Specific Complication are expressed as Number of patients and percentage of patients and compared across the Mode of Intervention using Pearson's Chi Square test for Independence of Attributes. The statistical software SPSS version 20 has been used for the analysis. An alpha level of 5% has been taken, i.e. if any p value is less than 0.05 it has been considered as significant.

**RESULTS****TABLE 1: AGE DISTRIBUTION OF PATIENTS IN BOTH GROUPS**

	MODE OF INTERVENTION		
AGE	ANTIBIOTIC IMPREGNATED POLYMETHYLMETHACRYLATE BEADS	WITHOUT ANTIBIOTIC IMPREGNATED POLYMETHYLMETHACRYLATE BEADS	Total
BELOW 30	5(25%)	5(25%)	10(25%)
31-40	5(25%)	6(30%)	11(27.5%)
41-50	5(25%)	5(25%)	10(25%)
51-60	5(25%)	3(15%)	8(20%)
ABOVE 60	0(0%)	1(5%)	1(2.5%)
Total	20(100%)	20(100%)	40(100%)

**TABLE 2: SEX DISTRIBUTION OF PATIENTS IN BOTH GROUPS**

	MODE OF INTERVENTION		
SEX	ANTIBIOTIC IMPREGNATED POLYMETHYLMETHACRYLATE BEADS	WITHOUT ANTIBIOTIC IMPREGNATED POLYMETHYLMETHACRYLATE BEADS	Total
FEMALE	4(20%)	4(20%)	8(20%)
MALE	16(80%)	16(80%)	32(80%)
Total	20(100%)	20(100%)	40(100%)

**TABLE 3: SIDE DISTRIBUTION OF PATIENTS IN BOTH GROUPS**

SIDE	MODE OF INTERVENTION		Total
	ANTIBIOTIC IMPREGNATED POLYMETHYLMETHACRYLATE BEADS	WITHOUT ANTIBIOTIC IMPREGNATED POLYMETHYLMETHACRYLATE BEADS	
LEFT	7(35%)	8(40%)	15(37.5%)
RIGHT	13(65%)	12(60%)	25(62.5%)
Total	20(100%)	20(100%)	40(100%)

**TABLE 4: SITE DISTRIBUTION OF PATIENTS IN STUDY POPULATION**

SITE	Frequency	Percent
Distal Femoral fractures	23	57.5
Proximal Tibial fractures	17	42.5
Total	40	100.0

**TABLE 5: MULLER'S CLASSIFICATION DISTRIBUTION OF PATIENTS IN STUDY POPULATION**

	Distal Femoral fractures	
	Frequency	Percent
M A + M B	18	78.26
M C	5	21.74
TOTAL	23	100.00

**TABLE 6: SCHATZKER'S CLASSIFICATION DISTRIBUTION OF PATIENTS IN STUDY POPULATION**

	Proximal Tibial fractures	
	Frequency	Percent
S I-S IV	14	82.35
S V-S VI	3	17.65
TOTAL	17	100.00

**TABLE 7: FRACTURE TYPE DISTRIBUTION OF PATIENTS IN BOTH GROUPS**

Fracture Type	MODE OF INTERVENTION		Total
	ANTIBIOTIC IMPREGNATED POLYMETHYLMETHACRYLATE BEADS	WITHOUT ANTIBIOTIC IMPREGNATED POLYMETHYLMETHACRYLATE BEADS	
III A	12(60%)	11(55%)	23(57.5%)
III B	8(40%)	9(45%)	17(42.5%)
Total	20(100%)	20(100%)	40(100%)

### Discussion

In our study population 32 patents were male and it comprises 80% of the study population. The age distribution shows it was more common in middle age group (below 40 years) and consists of 52.5% of study population. Our socio-economic structure consistent with this finding as road traffic accident is more common in males below the age of 40 years for their outdoor job habit.

Study also showed right sided involvement was 65% and 60% for respective groups. Of the patients 60% and 55% had Gustillo Anderson's open type IIIA fractures. Primary wound closure could not be done after optimum debridement for 15% of patients in both groups.

The antibiotic bead pouch technique had been used in those patients with encouraging results for preventing infection. Where the soft tissue coverage was not possible open wound is covered with water impermeable transparent layer of opsite.

Most organisms cultured from infected open fractures are nosocomial, it would be advantageous to provide an early barrier between the wound and the hospital environment. In a study by Carsenti-Etesse<sup>108</sup> and colleagues, showed that 92% of infected open fractures were caused by bacteria acquired in the hospital. Results from multiple studies have shown that ABPs can help reduce infection rates in such traumatic wounds.<sup>8</sup>

Discharge from open wound site was present at 6 weeks in 10% patients in whom PMMA beads were given in compare with 20% patients who were not treated with PMMA beads but it is not statistically significant ( $p=0.376$ ).

So in conclusion from clinical and pathological parameter it was seen that infection persist in 65% patient in control group as compared with 20% of patient in PMMA group and it was significant. ( $p=0.004$ ). At the analysis of infection at 3 months 25% of patient in control group still had infection where none of the patient remain infected in PMMA group. ( $p=0.017$ ). In those patients who were not treated with PMMA beads 1 patient remain infected.

Thus it was very clearly visible from our study that antibiotic PMMA beads had significant role in controlling infection in open fractures.

Henry and colleagues<sup>9</sup> reviewed 404 open fractures treated with either systemic antibiotic therapy plus an ABP or systemic antibiotic therapy alone. Acute wound infection rates were 2.7% for patients who received the combination therapy and 11.4% for patients who received systemic therapy alone.

Ostermann and colleagues<sup>10</sup> and several author in their study had documented a definitive role of PMMA beads in controlling infection in open fractures.

There results differ from our study in respect that they all included those patients who had sustained injury within 24 hours from presentation and they had large study group.

Analysing the relation between union and PMMA beads, significant relation have been found between radiological union and PMMA beads. Those patient who were treated with PMMA beads had a union rate 85% compared to only 50% in those who were treated without PMMA beads. ( $p=0.018$ ) at 24 weeks.

Summarising clinical and radiological parameter it was seen that 85% of patient who were treated with PMMA beads had union at the end of 24 weeks as compared to 50% of the patient who were not treated with PMMA beads.it was statistically significant ( $p=0.018$ )

Open fractures lead to soft tissue stripping and damage to the periosteal blood supply impairing vascularity resulting in necrotic surfaces which inhibit the normal biology of fracture healing.

Manoj Kumar Shaw and colleagues found significant association between infections ( $p$  value- 0.002, OR-6.11) and delayed union<sup>11</sup>. Open fractures ( $p$  value-0.000, OR-16)<sup>12</sup> were found to be strongly associated with delayed union. Similar association was obtained by Frey C and colleagues<sup>13</sup>. Similar findings were also obtained in other studies.<sup>14</sup>

Infection may result in instability at the fracture site. Complications due to infection like necrotic bone which is avascular discourages bone union. Osteolysis at the fracture site due to infection also produces poor bony contact resulting in delayed union.

On calculating the functional outcome only 35% of the patients in PMMA groups have less than 90° of flexion compared to 45% in control group. Whereas 50% of patients in PMMA group have knee flexion more than 110° compared to 20% of patients in control groups. This result is significant ( $p=0.018$ ).

Objective knee scoring system calculation also showed better result in PMMA group. Rasmussen's score at the end of 1 year showed 50% of patients had excellent results compared to 15% only in control group and it was statistically significant ( $p=0.011$ ) Neer functional knee score showed significantly ( $p=0.017$ ) better out come in PMMA groups compared to control group.

Articular fractures around knee most of the time leads to poor functional outcome of the patients. Fracture geometry involving the articular surface, infection in open fractures and pain restrict patient's compliance to do continuous aggressive active physiotherapy.

In our study only 4 patient needed further operation in control group compared to 1 patient in PMMA group. The 1 patient undergone further operation had implant prominence. Among the 4 patient in control group, who had undergone further operation 2 patient had uncontrolled infection and remaining 2 patient had non-union at the end of 1 year for which they had undergone revision surgery with autogenous bone grafting procedure.

Our study showed that 1 diabetic patient had persistent infection at the end of 6 months. It was statistically significant ( $p=0.002$ ). SooHoo et al<sup>15</sup>, Costigan et al<sup>16</sup> and concluded that systemic vascular disease and diabetes are the most important risk factors for immediate postoperative complications.

### Conclusion

Open fractures were always a challenge for orthopaedic surgeons. Treatment strategies revolutionized from early emergency amputation in pre-antibiotic era to limb saving surgeries with combined effort of orthopaedicians, plastic surgeons and vascular surgeons. With innovation of highly potent antibiotic newer method of drug delivery system also comes forward with promising results. So, from the above results we conclude that primary internal fixation for open peri-articular fractures around knee yielded better results when PMMA beads were added. However internal fixation should be attempted only when debridement is adequate and the wound is ready for coverage.

### References

1. Court-Brown CM, Clement N. Four score years and ten: an analysis of the epidemiology of fractures in the very elderly. *Injury*. 2009;40:1111-1114.
2. Ferguson TA, Patel R, Bhandari M, et al. Fractures of the acetabulum in patients aged 60 years and older: an epidemiological and radiological study. *J Bone Joint Surg Br*. 2010;92:250-257.
3. Carroll EA, Huber FG, Goldman AT, et al. Treatment of acetabular fractures in an older population. *J Orthop Trauma*. 2010;24:637-644.
4. Culemann U, Holstein JH, Kohler D, et al. Different stabilisation techniques for typical acetabular fractures in the elderly--a biomechanical assessment. *Injury*. 2010;41:405-410.
5. Laflamme GY, Hebert-Davies J, Rouleau D, et al. Internal fixation of osteopenic acetabular fractures involving the quadrilateral plate. *Injury*. December 12, 2010. [Epub ahead of print].
6. Herscovici D Jr, Lindvall E, Bolhofner B, et al. The combined hip procedure: open reduction internal fixation combined with total hip arthroplasty for the management of acetabular fractures in the elderly. *J Orthop Trauma*. 2010;24:291-296.
7. Ward AJ, Chesser TJ. The role of acute total hip arthroplasty in the treatment of acetabular fractures. *Injury*. 2010;41:777-779.

8. Guerado E, Cano JR, Cruz E. Surgical technique: intraacetabular osteosynthesis with arthroplasty for acetabular fracture in the octogenarian. *Injury*. 2010 May 10 [Epub ahead of print].
9. Haidukewych GJ. Acetabular fractures: the role of arthroplasty. *Orthopedics*. 2010;33:645.
10. Rogmark C, Carlsson A, Johnell O, et al. A prospective randomised trial of internal fixation versus arthroplasty for displaced fractures of the neck of the femur. Functional outcome for 450 patients at two years. *J Bone Joint Surg Br*. 2002;84:183-188.
11. Rogmark C, Johnell O. Primary arthroplasty is better than internal fixation of displaced femoral neck fractures: a meta-analysis of 14 randomized studies with 2,289 patients. *Acta Orthop*. 2006;77:359-367.
12. Parker MJ, Pryor G, Gurusamy K. Hemiarthroplasty versus internal fixation for displaced intracapsular hip fractures: a long-term follow-up of a randomised trial. *Injury*. 2010;41:370-373.
13. Parker MJ, Stedtfeld HW. Internal fixation of intracapsular hip fractures with a dynamic locking plate: initial experience and results for 83 patients treated with a new implant. *Injury*. 2010;41:348-351.
14. Keating JF, Grant A, Masson M, et al. Randomized comparison of reduction and fixation, bipolar hemiarthroplasty, and total hip arthroplasty. Treatment of displaced intracapsular hip fractures in healthy older patients. *J Bone Joint Surg Am*. 2006;88:249-260.
15. Skoldenberg O, Ekman A, Salemyr M, et al. Reduced dislocation rate after hip arthroplasty for femoral neck fractures when changing from posterolateral to anterolateral approach. *Acta Orthop*. 2010;81:583-587.
16. Bhattacharyya T, Koval KJ. Unipolar versus bipolar hemiarthroplasty for femoral neck fractures: is there a difference? *J Orthop Trauma*. 2009;23:426-427.