A Study of Management of Segmental Fractures of the Long Bones

D. Ramkishan[1], S.Y. Narsimulu[2]

ABSTRACT

Introduction: Segmental long bone fractures in high energy injuries are a challenging combination of bone and soft-tissue damage and loss. The present study was conducted to evaluate the various modalities of management of segmental fractures and to identify the complications encountered in the course of the treatment and follow up of the results.

Material and Methods: The current study was carried among 30 cases of segmental fractures. The fractures were evaluated clinically as well as radiologically and the modality of management was based on the type of fracture and associated injuries. Data so obtained was analyzed using the SPSS Version 17 software and, arranged according to characteristics and represented as a number and percentage of respondents.

Results: The mean age was 42.53 years. The right side was more frequently involved than left (17:13). There were 14 tibial, 10 femoral, 2 humeral, 4 radius/ulna fractures. Mechanism of injury was direct in 17, indirect in the remaining 13 patients. In 22 patients the cause was road traffic accident, 6 were due to fall from height, and 2 were due to fall after slipping. 11 were associated with other injuries. Intramedullary nailing was done in 9 tibiae, 10 femorii, 1 humerus and 3 radius / ulna. Dynamic compression plating was done in 1 humerus and 1 radius / ulna. Manipulative reduction and cast application was done in 5 tibiae and 1 radius / ulna. External fixator was applied in 4 tibiae and 1 femur.

Conclusion: Conservative management still has a role especially in those with undisplaced closed segmental fractures who are either unfit for major surgery as well as those who have not sustained any other system or bone injury. External fixators are important tools in the management of Grade III compound fractures. Static interlocking Intramedullary nailing is the best possible option especially in those with large open fractures once the infection is controlled.

Keywords: segmental long bone fracture, intramedullary nailing, delayed union, reaming, plating.

INTRODUCTION

Segmental long bone fractures in high energy injuries are a challenging combination of bone and soft-tissue damage and loss.[1] The state of the surrounding soft tissues and the local blood supply to the bone are the most important factors determining the tendency of the fracture to heal. This is usually compromised in segmental fractures because of injury to the surrounding soft tissues in addition to the compromised blood supply to the middle segment. This often leads to nonunion or delayed union.[2] These fractures are generally caused by a high-energy trauma, motor vehicle and motorcycle crashes, falls from a height, industrial and train accidents.[3]

It was the study in the eighties and nineties that significant understanding of these fractures and its special challenges in management have studied and treatment protocols recommended. Yet there is need for good studies regarding the management and behavior of these fractures. Thus, the present study was conducted to evaluate the various modalities of management of segmental fractures and to identify the complications encountered in the course of the treatment and follow up of the results.

MATERIAL AND METHODS

The present study was carried among 30 cases of segmental fractures which were treated at the department of Orthopaedics and Traumatology, at Osmania General Hospital, Hyderabad, Aakash Orthopaedic Hospital, Shadnagar, Navodaya Hospital, Mahabubnagar from October 2005 to May 2014. The results of the 30 patients were studied and analysed. The follow up period ranged from 3-28 months. The average follow up period being 15 months. The fractures were evaluated clinically as well as radiologically (figure-1) and the modality of management was based on the type of fracture and associated injuries.

Out of 14 tibial fractures, 9 were treated with static intramedullary nail, 3 with closed reduction and cast application and 2 with external fixator. Out of 10 femoral fractures, 11 were treated with intramedullary nail. Out of 2 humerus fractures 1 was treated with intramedullary nail and 1 with dynamic compression plate with MIPO technique. Out of 4 radius / ulna fractures, 3 were treated with intramedullary nail, 1 with dynamic compression plate.

STATISTICAL ANALYSIS

Data so obtained was analyzed using the SPSS Version 17 software and, arranged according to characteristics and represented as a number and percentage of respondents.

RESULTS

There were 25 males and 5 female patients. The ages ranged from 20 to 80 years. Out of these 15 patients (50%) were between 21-40 years. One patients was below the age of 20 years and 14 were of age group above 40 years. The mean age was 42. 53 years. Among 25 cases (83.33 %) were males and 5 (16.67%) were females. The incidence of segmental fracture on right side was 17 (56.67%) and on left side was 13 (43.33%).

The right side was more frequently involved than left (17:13). There were 14 tibial, 10 femoral, 2 humeral, 4 radius/ulna fractures. Mechanism of injury was direct in 17, indirect in the remaining 13 patients. In 22 patients the cause was road traffic accident, 6 were due to fall from height, and 2 were due to fall

[1]Associate Professor, Department of Orthopaedics, RIMS (Rajiv Gandhi Institute of Medical Sciences), KADAPA, Andhra Pradesh. [2]Associate Professor, Department of Orthopaedics, SVS Medical College, Mahabubnagar, Telangana State, India

Corresponding author: Dr. D. Ramkishan, Associate Professor, Department of Orthopaedics, RIMS (Rajiv Gandhi Institute of Medical Sciences), Kadapa, Andhra Pradesh.

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after slipping. 11 were associated with other injuries.
18 of these were open and 12 were closed fractures. Of these 18, 6 were of Grade I, 5 were Grade II, 5 were Grade IIIA, and 2 were Grade IIIB (Figure-2). 9 out of 14 tibial fractures were open whereas 3 out of 10 femoral fractures are open, 1 out of 2 humeral fractures were open, and 2 out of 4 radius/ ulna fractures were open.
Average length of the segment in tibial fractures is 11.5 cms, in femoral fractures 8.6 cms, in humeral fractures 4.25 cms and in radius / ulna fractures 5.13 cms.

Etiology of segmental fracture: In our series 16 cases were due to road traffic accidents. 8 were due to fall from height whereas 6 cases were due to other causes such as fall from slipping. Among tibial fractures majority 11 were due to road traffic accident and only 4 were due to fall from height and 1 was in the category of 'others'. Out of 10 femoral fractures all 10 (100%) were due to R.T.A. Among humerus fractures 1 was due to fall from height and the 'others' 1. Out of 4 radius / ulna fractures 2 were road traffic accident, 2 were due to fall from height.

Mode of injury: In our series 17 (56.67%) were due to direct trauma and 13 (43.33%) were due to indirect trauma (Table-2).

Type of fractures: In our series our series of 30 segmental fractures 7 (23.33%) were of type 1, 10 (33.33%) were of type ii, 8 (26.66%) were of type iii, 4 (13.33%) were of type iv and 1 (3.33%) was of type v (Table-2).

Length of the segment in tibial fractures and its correlation with time of union: 1 patient had segment </+5 cms and united in about 16 weeks, 6 patients had segments 6-10cms long and united at an average of 18.2 weeks with 1 delayed union. 8 patients had segment of 11-15 cms and united at 29.43 weeks with 1 nonunion.

Demographic details	
Total patients	30
Male	25
Female	5
Mean Age	42.53 years
Right side Fractures	17
Left side Fractures	13

Table-1: Demographic details of the patient

Mode of management: Intramedullary nailing was done in 9 tibiae, 10 femorii, 1 humerus and 3 radius / ulna. Dynamic compression plating was done in 1 humerus and 1 radius / ulna. Manipulative reduction and cast application was done in 5 tibiae and 1 radius / ulna. External fixator was applied in 4 tibiae and 1 femur (Table-2).

Time taken for union: Out of 14 tibial fractures 3 treated with conservative management united by an average of 18.67

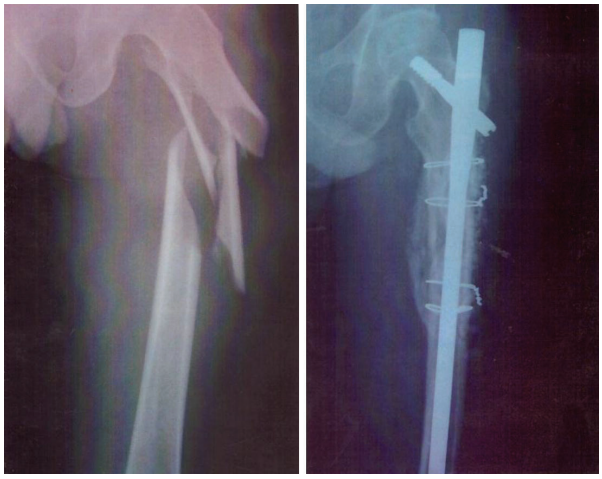

Figure-1: Pre-operative and post-operative radiographs of segmental fracture of femur bone

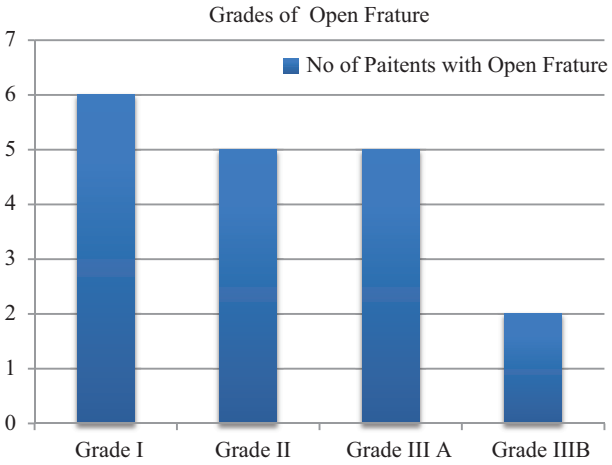

Figure-2: Distribution of patients according to grades of open fracture

Injury	**No. of patients**
Mode of Injury	
Direct trauma	17 (56.67%)
Indirect trauma	13 (43.33%)
Type of fracture	
Type 1	7
Type 2	10
Type 3	8
TYPE 4	4
Type 5	1
Mode of Management	
Intra Medullary Nailing	9 Tibiae, 10 Femori, 1 humerus and 3 Radius / ulna.
Dynamic compression platting	1 humerus and 1 Radius / Ulna.
Manipulative reduction and cast application	5 tibiae and 1 Radius / Ulna
External Fixator	External fixator was applied in 4 Tibiae and 1 Femur.

Table-2: Description of injuries

weeks whereas 11 treated surgically united by 29.25 weeks, but 1 nonunion and 1 delayed union resulted. Of the 10 femoral fractures treated surgically united in 38 weeks. Of the 2 humerus fractures treated surgically united in 22 weeks. The 4 radius / ulna fractures, treated surgically united by 13 weeks.

Duration of fractures and delay in treatment: In most of the cases treatment was started within 24 hours as these cases were due to fall from height or road traffic accidents. A few cases were initially treated in peripheral hospitals and were reffered here for further management. The operative procedures for open fractures involved initial debridement and definitive surgery around 10-15 days. For closed fractures operation was done within 5-6 days on an average. Two patients underwent multiple surgical procedures.

Complications - Malalignment: Of more than or equal to 10 degree was considered to be significant. Malalignment occurred especially in those who were treated conservatively and more so at the distal fracture site. Malalignment was not gross in any of these patients and hence there was no need for any secondary operative procedures.

Shortening: One patient has gross shortening (6cms) and was advised shoe raise to overcome this disability.

Delayed union and non – union: One patient with segmental fracture of tibia treated conservatively had resulted in non union. One patient with segmental fracture of tibia treated by surgery went into delayed union.

Stiffness: Of adjacent joints occurred in almost all cases treated either conservatively or surgically, which improved considerably with physiotherapy. But range of movement was better in those treated surgically when compared to those treated conservatively.

Infection: varying degrees of infections was in many cases of compound fractures which was usually superficial. Staphyococcus aureas and pseudomonas were the commonest offending organisms. These healed with debridement, regular dressing and antibiotics except in one case in whom the infection around the implant led to osteomyelitis of the femur and discharging sinus was present. Later the implant was removed and fracture went into non union.

Other complications: No case of fat embolism was encountered in this series. No case of compartment syndrome was encountered in this series. Two patients with tibia fractures were having feeble distal pulses but improved with definitive treatment.

Neurological and vascular complications: 1 patient with femoral fracture and 1 with humerus fracture had neurological deficit. 2 patients with tibial segmental fractures has vascular deficits.

DISCUSSION

Segmental fracture is a fracture of long bone at two different levels, with the intermediate fragment possessing an intact tubular or split structure and usually caused by high energy trauma and is associated with severe soft tissue injuries.[4] In the present study, most of the patients were men and 50% were of the age group 20-40 year i.e. those who were leading an active life. All these fractures and hence needed more attention towards preventing infection. All these fractures were associated with significant soft issue injuries.

Out of 14 tibial fractures 3 were treated by manipulative reduction and above knee cast application out of which one fracture resulted in nonunion. 11 were treated by surgery. Out of 11 cases, 8 were treated with interlocking intreamedullary nailing which united well, and remaining 3 cases were treated with external fixation. Malalignment occurred in 2 out of 5 fractures treated conservatively where as no patients surgically treated had significant malalignment. Shortening was more in those who underwent conservative management, whereas those who underwent operative management had minimal shortening. Open intramedullary nailing technique offers the advantages of producing good reduction and having short operative times, but it increases the risk of infection and union delay, compared with the closed nailing method and can cause cosmetic problems.[5]

Closed intramedullary nailing has essentially the major advantage of not exposing the fracture site thus drastically reducing the rates of infection, non-union and avascularity of the middle fragments. The theoretical risk of damaging the blood supply of the middle fragment due to torsion while reaming has been disproved. But this method demands specialized skill, equipment and image intensifiers and it still does not assure rotational stability nor prevents shortening in case of comminution. Closed interlocked nail used for the femur and tibia is an excellent procedure despite requiring expensive equipment and specialized skill. Static nailing is preferred and dynamization if required can be done after 12-16 weeks. Static interlocking nails prevent shortening and provide rotational stability in addition to the other advantages of closed nailing.[6]

In the present study, one patient with compound type I segmental fracture of tibia was treated by debridement, closed reduction and above knee cast application; but the fracture did not unite. The number of cases in this group was 10 and majority of them (9) were treated by open / closed reduction and static intramedullary interlocking nailing Recon nailing, long PFN which united well. One patient with grade III compound segmental fracture was treated by debridement and extrernal fixation. But the fracture went into non union. Only 2 cases humeral segmental fractures were encountered one patient with grade I compound segmental fracture humerus treated by intramedullary nailing and one treated by plating. Out of 4 cases, all cases were treated surgically in which 3 with intramedullary nailing and 1 with dynamic compression plate. All these fractures united well. Thus, closed / open reduction with intramedullary nailing is the best possible option in segmental fractures of long bones.

Intramedullary nailing is a common method for the fixation of both closed and open tibial fractures. Intramedullary reaming offers better bending and rotational stability as it allows the insertion of larger-diameter and tighter-fitting nails. Additionally, as it provides higher resistance to axial and torsional forces as insertion of locking screws at both ends of the nail increases the biomechanical strength of the construct.[7]

Larsen LB et al[8] commenced a study to compare healing and complications between reamed and unreamed nailing in tibial shaft fracture patients and found that unreamed nailing may be related with higher rates of secondary operations and malunions compared with reamed nailing.

Obremskey WT et al[9] conducted a study to evaluate current practice and practice variation among 379 orthopaedic trauma surgeons and concluded that substantial variation is present in the timing of bone graft placement after soft tissue healing as well as the source and form of graft utilized.

Delayed union and mal-union incidence is high in these fractures because of decreased vascularity, stripping of the bone, injury to surrounding muscles and rotational instability across one of the fractures sites when fixed with intramedullary nailing. The solution lies depending on the individual problem, autogenous cancellous bone grafting, dynamization of a static interlocking nail, use of dynamic compression plate etc.[10]

The anatomical pattern of the shaft of the humerus makes it vulnerable for residual fracture site distraction, mainly where the sagittal diameter of the distal part is small. Residual fracture site distraction increases the risk of delayed union / nonunion, that demands additional procedures to obtain union. Thus, interlock nailing has not been recommended as standard method of management for a humeral diaphyseal fracture in contrast to more tubular bones like the femur and tibia.[11] In the present study, shortening was the most common complication seen especially in those treated by conservative management. Shortening was about 2 cm on an average.

Intramedullary nailing is considered as treatment of choice for adult tibial shaft fractures, in spite of the fact that controversy is present regarding the preference of reamed or unreamed intramedullary nailing. In view of the ease of performing the method and the decreased operative time, unreamed interlocking nailing may have an edge over reamed interlocking nailing.[12,13]

CONCLUSION

Segmental fractures most commonly occur in the young males. Infection rates are higher as majority of these are open fractures with more severe soft tissue injury. Conservative management still has a role especially in those with undisplaced closed segmental fractures who are either unfit for major surgery as well as those who have not sustained any other system or bone injury. External fixators are important tools in the management of Grade III compound fractures. Static interlocking Intramedullary nailing is the best possible option especially in those with large open fractures once the infection is controlled. The longer the length of the segment, the longer the period required for union. Proximal fracture unites significantly earlier than the distal fracture. Joint stiffness is the commonest complication which is more seen in cases treated conservatively than surgically.

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