

# Results of Distraction Compression and Compression Distraction in Segmental Defects of Tibia with the Use of Ilizarov's External Fixator

1. Khalil Ahmad Gill 2. Ahmad Awad 3. Mukhtar Ahmad Tariq 4. Kamaran Salik

1. Assoc. Prof. 2. Asstt. Prof. 3. Sen. Registrar 4. Prof., Department of Orthopaedics, Nishtar Medical College/Hospital, Multan

## ABSTRACT

**Objectives:**-To compare the results of distraction-compression and compression-distraction in segmental loss of tibia by Ilizarov extent fixator and to see the functional end results of each procedure.

**Study Design:** Comparative study.

**Place and Duration of Study:** This study was carried out in the Department of Orthopaedic, Nishtar Hospital, Multan from April 2008 to March 2010.

**Materials and Methods:** A total of 30 cases were included in the study.

**Results:**-Gap non-union in tibia is a frequently encountered problem in open tibial injuries. Their treatment have been unsatisfactory until the introduction of distraction histeogenesis by Ilizarov, before the end results were often amputation. Gap non-union of upto 5 cm can be managed by initial compression, later on the LLD is addressed and distraction histeogenesis whereas gap of >5 cm are amicably managed by segment transport i.e. distraction and later compression between the transported segment to other end of the fracture.

**Conclusion:** Both methods are excellent if the limitations and principles are followed. Our recommendations are gaps of < 5 cm to be managed and compression-distraction of gaps of >5 cm to be managed with distraction-compression mode of treatment.

**Key Words:** Distraction Compression, Compression Distraction, Segmental Defects of Tibia, Ilizarov's External Fixator

## INTRODUCTION

Segmental skeletal defect have always presented a perplexing problem for the Orthopedists. These segmental defects are most common in tibia than any other long bone of body. It may be caused by a high-energy trauma, particularly the road traffic accidents, fall from height and gun shot injuries.

The basic object of treatment of fractures of tibial shaft is to restore anatomy and regain function as early as possible. When a tibial fracture is accompanied by segmental defect, it presents a challenging problem, particularly in the presence of infection and instability. Significant bone loss is seen in only a few of tibial fractures, whereas it occurs in 17%-to-40% cases of open fractures<sup>1</sup>.

A segmental defect may be due to bone loss at the time of original trauma, removal of nonviable bone fragment at the time of initial debridement, removal of dead bone in chronic osteomyelitis or defects due to excision of tumor. In the past the treatment of choice was amputation<sup>2</sup>.

There have been many methods to treat segmental defects of tibia<sup>3</sup> like by-passing the defect using fibula as the main stabilizer, this includes postero-lateral bone grafting and fibula-pro-tibia procedures. Filling the defect; this includes vascularised auto-geneous bone grafting, transplantation of allograft bone and segment transport and open bone grafting (Papineau's technique).

The concept of segment transport by distraction osteogenesis, for the treatment of segmental defect has been credited to Gavril Abramovich Ilizarov. He gave the concept of bone segment transport<sup>4</sup>. In year 1951, he developed circular ring external fixator and used it to treat various orthopaedic problems. In year 1956, during correction of an ankylosed knee after open osteotomy, he noticed callus in distraction gap. He developed a system in orthopaedics based on the ability of new bone formation in distraction gap under appropriate conditions, as well as to correct complex mal-alignment with minimal surgery and to overcome shortening and joint contracture by gradual stretching of soft tissue.

New bone formation can be identified within one week of the start of distraction with dual energy X-ray. As distraction proceeds, the gap is filled with the distracted callus, which later on becomes consolidated<sup>5</sup>.

The defect is closed at the time of surgery and both proximal and distal fragment ends are compressed. Length is restored by corticotomy in the metaphyseal region of either fragment, followed by gradual distraction at the rate of 1 mm/day after allowing 10 days for callus formation<sup>6</sup>. A fibular osteotomy is done as a part of initial surgery before compression of the fragments.

Bone segment transport is used to treat large bone defects. After application of Ilizarov ring fixator, a corticotomy is performed in the metaphyseal region of either one or both fragment. Gradual distraction is

started to bridge the gap after ten days. Fibula is left intact during segment transport to increase stability<sup>7</sup> of the construct.

Ilizarov method which was developed during the 6<sup>th</sup> and 7<sup>th</sup> decade of the last century has offered a good alternative for the management of gap non-union, gaps after resection of tumours and infected non-union in addition to other benefits of this procedure<sup>8</sup>.

Certain advantages inherent to the Ilizarov frame design are difficult to produce with large pin fixator. These include functional weight bearing during treatment, progressive correction of angulatory and torsional deformities and ability to apply compression, distraction and correction at multiple levels with single frame construct.

In compression distraction the non-union site is compressed earlier on whereas the length is regained subsequently. On the other hand in distraction compression the gap is bridged 1<sup>st</sup> and the compression across gap is the last event if the docking has occurred without any problem and then the compression is applied. This causes considerable increase in the time duration for union to occur to gain strength for assisted full weight bearing.

## MATERIALS AND METHODS

This comparative study was carried out in the Department of Orthopaedic, Nishtar Hospital, Multan from April 2008 to March 2010. A total of 30 cases were included in the study. All patients with gap non-union of tibial shaft were included in the study. Their age ranged from 25-58 years. Both sexes were included, though males were many more than female patients.

They were divided in two groups (A & B). In group-A the gap at non-union was < 5 cm whereas gap was > 5 cm in group-B patients. For group-A patients compression distraction method was adopted and for group-B distraction compression was adopted.

## RESULTS

In this study we included 30 patients. These patients had been divided in 2 groups equally. In group-A 11 (73.3%) patients were male and 4 (26.7%) were female. The patients were of the age group ranging from 16-58 years. These patients had gap non-union of tibia with a bone loss of 5 cm or less. In group-B, 11 (73.3%) patients were male and 4 (26.7%) were female. The patients were of the age 15- 55 years. The patients in this group had bone defect of 5 cm to 10 cm.

Pin tract infection occurred in 5 patients. In two out of these five have mild degree for which daily dressing was done. One case had moderate infection. Oral antibiotics were advised while in remaining two having severe pin tract infection, wires have to be changed in group-A. Pin tract infection of mild degree occurred in 3 patients (20%), while severe pin tract infection

occurred in one patient (6.66%), wire breakage occurred in three patients (20%). Two patients had skin invagination (13.33%) and persistent infection at fracture site remained in two patients (13.33%). Two patients had residual angular deformity (13.33%), 5° valgus in one and other had 5° anterior angulation in group-B.

In group-A the proximal 3<sup>rd</sup> was involved in 3 patients 20%. In 7 patients 46.7% the middle 3<sup>rd</sup> was involved site while 5 patients (33.3%) the distal 3<sup>rd</sup> of tibia was involved. Corticotomy was done in proximal 3<sup>rd</sup> of tibia in 10 patients (66.7%). In five patients corticotomy was done in distal 3<sup>rd</sup> of tibia (33.3%). The distraction was started 7<sup>th</sup> to 10<sup>th</sup> day of surgery. It was tried to start partial weight bearing in the 1<sup>st</sup> week. Pain had settled and most of the patients in group-A started weight bearing in 12 days of surgery. The union at fracture site was achieved between 18 to 30 weeks. The bone gap filled with distraction consolidated in 24 weeks to 37 weeks in all patients with average 30.13 weeks. The Ilizarov was removed 30 weeks to 42 weeks and PTB applied for 6.8 weeks. Two patients had residual mild infection at fracture site while wire breakage occurred in two patients. One patient had 5° varus deformity at final assessment which was done 3 months after removing the patellar tendon bearing cast while another has 5° valgus angulation in group-A.

To reduce the skin gap and to cover the bone cross leg flap was done in five patients (33.3%), GN flap in three patients (20%) and soleus flap in one 6.7%. The time interval between injury and application of Ilizarov was from immediate to 10 months (average 5.36 months). The shortening was from 5 cm to 10 cm (average 6.36 cm). Corticotomy was done in proximal tibia in 11 patients (73.33%) and in 4 patients distal tibia was corticotomy site (26.7%). The distraction at corticotomy site was started as 1 mm/day basis. It was started from 7<sup>th</sup> to 10<sup>th</sup> day of surgery. Dynamization of fixator was done 20 to 24 weeks (average 25.33 weeks). Consolidation was achieved from 24 weeks to 40 weeks (average 30.93 weeks). Full weight bearing was started after consolidation of fracture site from 24 weeks to 44 weeks (average 33.46 weeks). Ilizarov frame was removed from 30 weeks to 49 weeks (average 39 weeks). PTB was applied for 6-8 weeks so that union was attained in all patients in group-B.

The most of the patients in group-A have history of road traffic accident 11 (73.3%) patients while 2 (13.3%) have history of fall of heavy object on legs. Two (13.3%) patients have history of FAI. The time interval between trauma and application of Ilizarov frame vary. It ranges from 2 months to 7 months (average 4.26 month) and overall bone gap was 3.9 cm. In group-B, the mode of injury was road traffic accident in 9 (60%) patients, fall of heavy object on leg in 2 (13.3%) patients; FAI was in 2 (13.3%) patients as shown in Table-1.

The fracture took place in right side in 9 (60%) patients while left side was involved in 6 (40%) patients in group-A. Whereas in group-B, 8 (56.4%) patients had left side involvement and 7 (46.6%) had right side involved (Table-2).

**Table No.1: Causes of gap non-union tibia**

| Causes               | Group-A    | Group-B |
|----------------------|------------|---------|
| RTA (open fracture)  | 11 (73.3%) | 9 (60%) |
| Gun shots            | 02 (13.3%) | 3 (20%) |
| Fall of heavy object | 02 (13.3%) | 3 (20%) |

**Table No.2: Side involvement**

| Side  | Group-A | Group-B   |
|-------|---------|-----------|
| Right | 9 (60%) | 8 (56.4%) |
| Left  | 6 (40%) | 7 (46.6%) |

## DISCUSSION

Non-union of tibia is considered the most frequently observed, congenital, developmental or post-traumatic, long bone non-union. Among the complications of fractures, bone loss, non-union is most difficult to treat. In our study 30 patients with bone loss non-union were treated with Ilizarov method. They were reviewed with respect to age, sex, site and side of non-union, presence or absence of infection, length of bone loss, leg length discrepancy, bone length achieved, union achieved and complications in our patients.

The majority of our patients were young, 33.3% of patients were in their third and fourth decade. Average age among our patients was 30.3 years. Paley et al in their study showed average age of 34 years among their patients<sup>7</sup>. In a study showed average age of 34 years among their patients<sup>9</sup>. In another study showed average age 24 years in their patients with segmental defects of tibia<sup>10</sup>. Green et al in their study found average age of 32.8 years. Pasha et al showed average 27.9 years with bone loss non-union<sup>11</sup>.

Male population was predominant in our study, 73.3% of our patients were male. Other studies showed 76% male and 24% female<sup>7</sup>. whereas predominance of 64.3% was shown in a study to treat non-union with bone loss with Ilizarov method<sup>12</sup>. Ilizarov and Ledyayev also showed male predominance 71.42% in their 21 cases of segmented defect treated by segment transport<sup>13</sup>. Awais and Akhtar found 80% males in treating tibial defects with segment transport<sup>10</sup>.

In our study, right tibia was mostly affected (60%). in a study it is also found 70% of tibia and 30% femoral non-unions<sup>10</sup>. Tibia was most often involved, 65.62% had tibia non-union with bone loss. Right tibia was mostly affected 62.7%<sup>14</sup>. Bone bone loss or shortening is usually caused by resection of dead bone during debridement of open fractures caused by RTA, FAS, fall of heavy object and resection of tumour. The average bone loss in our study was 5.2 cm (ranges 3-10 cm).

Average bone loss in study conducted by Paley et al was 6.2 cm<sup>7</sup>. Another study showed 5.1 cm bone defect. In a latest study, 6.4 cm bone defect was treated with Ilizarov method<sup>14</sup>.

Open fractures due to RTA were responsible for 73.3% of segmental defects and FAI 13.3% followed by resection of dead bone. In one study it is showed that predominant cause of segmental defect was open fractures in 77% cases and osteomyelitis in childhood in 23% cases<sup>15</sup>. Defect can be filled by segment transport. The new bone in distraction gap is formed eliminating need for bone grafting in fairly good number of patients 83.33%. Axial deviation of the segment can occur if segmental defect is large<sup>16</sup>.

In our study, we had excellent results in 73% of patients, good results in 20% of patients, fair results in 6% of patients and poor results in 1% of patients. Tucker et al in their study found excellent results in 42.8%, fair results in 28.5% and poor results in 28.5%. Pasha showed excellent in 50% patients, poor results in 16.6% of patients.

Pin tract infection occurred at 10% insertion sites and 3.3% required removal and curettage because of loosening. It is found 29.6% pin tract infection but only 1.1% required removal and curettage of pin tract<sup>17</sup>. Pin tract infection occurred at 44% insertion sites<sup>14</sup>. The lower rate of pin tracts infection in our series was due to meticulous care during insertion and postoperative care emphasized to the patients.

In our study, ankle stiffness was observed in 20% of the cases that was treated with physiotherapy, knee contracture in 12.3%, slight equinus contracture in 6.66% that was treated with physiotherapy the major complications seen were delayed consolidation, Severe pin tract infection, skin invagination & Angulation.

Paley et al had found equinus deformity in 20% cases and amputation had to be performed in one case (4%)<sup>16</sup>. Green et al found pin tract infection commonly in treating segmental defects with Ilizarov method. One of their patients required amputation. Other complications in their patients included peroneal nerve paraesthesia, edema, early consolidation and joint contractures<sup>11</sup>.

Ilizarov method is a comprehensive approach to all aspects of tibial non-unions and bone defects. This is only a semi invasive method as compared to much more invasive methods. It has high success rate, a low complication rate and allows immediate weight bearing and functional mobilization of the joints involved. The loading physiologic certainly helps in facilitating mineralization and consolidation of the regenerate bone, when distraction histogenesis is being used to bridge the gap. The subsequent lengthening not only reduces the LLD created but also shortens the time duration of union at the gap ends of fracture early on. The difference between the compression distraction and distraction compression observed is that compression distraction only upto certain length i.e. <5 cm can be

compressed softly whereas in distraction compression any amount of gap can be bridged.

In distraction compression in additional procedure such as fibulectomy is needed if there is no LLD. Whereas in compression distraction fibulectomy has to be performed to allow for compression the adding one wire, produce to the setups with subsequent regaining of length.

## CONCLUSION

Comparing the results of both procedures it becomes evident that both methods are acceptable under the limitation in which they are performed. Small gaps are good for compression distraction mode of management whereas large gaps of >5 cm should be managed with distraction compression method. As both methods give equally good comparable results. In our view the condition of the patients problem necessitates the choice of appropriate method, the Ilizarov apparatus is a good system to address these complex problems in satisfactory manner with least inconvenience to the surgeon, this helps in psychological well being of the patient as they are provided with a positive hope for satisfactory management with early weight bearing. Managing this series with Ilizarov method of bridging the gap has given us confidence in offering it as a primary mode of treatment in complicated open injuries with segmental loss and also using it as a primary mode of management in bone resection for tumour surgery where limb salvage is possible.

## REFERENCES

1. Eralp L, Kocaglu M, Yusof NH. Distal tibial reconstruction with use of a circular external fixator and an intramedullary nail. *JBJS Am* 2007; 89: 2218–24.
2. Mateen MA. Ilizarov techniques in orthopaedic surgery. *J Surg* 2001; 23: 10-2.
3. Nho SJ, Helfet DL, Rozbruch SR. Temporary intentional leg shortening and deformation to facilitate wound closure using the Ilizarov/Taylor spatial frame. *J Orthop Trauma* 2006; 20: 419–24.
4. Rozbruch SR, Kleinman D, Fragomen AT. Limb lengthening and then insertion of an intramedullary nail: a case-matched comparison. *Clin Orthop Relat Res* 2008; 466: 2923–32.
5. Ilizarov GA. The classic, the replacement of long tubular bone defects by lengthening distraction osteotomy of one of the fragment. *Clin Orth* 1992; 280: 07-10.
6. Pavolini B, Maritato M, Turelli L, Arienzo M. The Ilizarov fixator in trauma. *J Orthop Sci* 2000; 5: 108-13.
7. Paley D. Current techniques in limb lengthening. *J Pediatr Orthop* 1988. 8-73.
8. Schwartzman V, Martin SN, Ronoquist RA, Schwartzman R. Tibial fractures. The Ilizarov alternative. *Clin Orthop* 1992; 278: 207-13.
9. . Linh, Huy NH, Feibel, Robert J. Tibial Lengthening Over an Intramedullary Nail. *Technique Orthop* 2009; 24(4): 279-88.
10. Song HR, Oh CW, Mattoo R. Femoral lengthening over an intramedullary nail using the external fixator: risk of infection and knee problems in 22 patients with a follow-up of 2 years or more. *Acta Orthop* 2005; 76: 245–52.
11. Green SA, Jackson JM, Wall DM, Marinow H, Ishkanian J. Management of segmental defects by the Ilizarov intercalary bone transport method. *Clin Ortho* 1992a; 280: 136-42.
12. Ilizarov GA, Ledyayev. The classic – replacement of long tubular bone defects by lengthening distraction osteotomy of one of the fragment. *Clin Orthop* 1992; 280: 7-10.
13. Zaidi SRA. The Ilizarov method - A modern orthopaedic procedure for your patients. *Rawal MED J* 2000; 3: 45-50.
14. Oh CW, Song HR, Roh JY. Bone transport over an intramedullary nail for reconstruction of long bone defects in tibia. *Arch Orthop Trauma Surg* 2008; 128: 801–8.
15. Tranquilly LP, Merolli A, Perrone V, Caruso L, Giannotta L. The effectiveness of the circular fixator in the treatment of post-traumatic nonunion of the tibia. *Chir Organi Mov* 2000; 85: 235-42.
16. Paley D, Catagni MA, Argnani F, Villa A, Benedetti GB and Cattaneo R.: Ilizarov treatment of tibial non union with bone loss. *Clin Orthop* 1989; 241: 146.
17. Aronson J, Harp JH. Mechanical consideration in using tensioned wires in a transosseous external fixator system. *Clin Orthop* 1992; 280:23-9.

### Address for Corresponding Author:

**Dr. Khalil Ahmad Gill**

Assoc. Prof. Department of Orthopaedics, Nishtar Medical College/Hospital, Multan