

# A CLINICAL STUDY OF MANAGEMENT OF COMPOUND FRACTURES OF TIBIA USING EXTERNAL FIXATION DEVICES

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## ABSTRACT

### BACKGROUND

Compound fracture of tibia has been a debatable issue since ages. In the past, infection and infected non-union were the common complications making patient non-ambulatory for longer periods and permanently disabling him and also leading to fatal complications.<sup>1</sup> In pre antibiotic era, the main methods of treatment were dressings, splintage and early amputation to save life.<sup>2</sup> First true and workable external fixator was introduced by Clayan Paekill of Denver in 1897<sup>3,4</sup> and modified gradually to a versatile multirole fixation devices by virtue of which many limbs are now a days are saved which otherwise would have been amputated.

### MATERIALS AND METHODS

Total of 40 patients of various grades of compound injuries were studied where only external fixator was used till union of fracture. In our study, 36 (90%) patients were males and majority of patient (60%) were of 20-30 years age group. Right extremity was involved in 23 (57.5%) of cases and middle third of shaft of tibia was involved in 28 (70%) patients. Average time of union was 25.1 weeks (11-40 weeks) whereas in 18 (45%) of patients fracture united earlier at 11-15 weeks majority of them belonged to Grade-II injury. Minimum surgeries were 3 (30%) whereas 1 (2.5%) patient underwent 10 surgeries. Union time in 3 patients was delayed because infected non-union and soft tissue and skin loss, these patients were managed by bone clearance, free flap coverage and bone transportation. All patients were followed for two years before concluding the study.

### RESULTS

Among 40 patients under study, 36 (90%) were males and both sides were involved equally. 24 (60%) patients were of age group 20-30 years and middle third fracture was in 28 (70%) of cases. Union time was 11-15 weeks in 28 (70%) of cases where as 2 (5%) cases took as long as 35- 40 weeks because of multiple procedures to salvage limbs which earlier used to be amputated because such infected non-unions were considered dangerous for patients. Minimum three surgeries were undertaken in 13 (30%) cases; whereas maximum of 8-10 surgeries were undertaken in 3 (7.5%) of cases. Excellent results were reported in Grade-II (50%); whereas 3 (7.5%) cases had acceptable results. None of cases in our study had poor results.

### CONCLUSION

After two years of analysis of said study, it was concluded that external fixator is a wonderful fixation device in treatment of compound injuries of tibia and results are even comparable to interlocking nailing of closed fracture tibia with Gustilo's grade II injuries. External fixator has advantage of minor adjustments of fracture alignment if required, early weight bearing, management of soft-tissue coverage, rotation of flap and even free flap coverage keeping bones in proper alignment. There is no need of converting to interlocking nailing following skin healing as union can be achieved on external fixator and also brace may be used following final removal of fixator. Only Ilizarov fixation system and Hoffman external fixation system can salvage limbs with infected gap non-union, by infected bone clearance and distraction osteoneogenesis (bone transportation).

### KEYWORDS

External Fixator, Compound Fracture, Free Flap, Skin Grafting, Bone Transportation.

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### BACKGROUND

Open fracture of leg is quite common especially due to two-wheeler accidents where unprotected limbs get crushed.

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Wounds are often smeared with road side contaminants. In our setup, delayed transportation to hospital and surgery time matters a lot as for outcome of injury is concerned. The normal protocol for any compound fracture of leg is initial thorough debridement, soft tissue coverage if possible, and external fixation with a suitable external fixation device. External fixator can be changed to internal fixation with undreamed or reamed interlocking nail, and can be continued to achieve union.

Goals of treatment in compound fracture tibia are prevention of infection, early initiation of appropriate antibiotics, soft tissue coverage and achieving fracture union and restoration of function of limb. Important surgical

procedures include local flap coverage, free flap coverage, skin grafting and bone transportation etc.

Historically, the 6-hour rule has been employed as the time limit within which an open fracture should be taken to operating room for initial debridement. Many factors influence this parameter including the availability of operating room, availability of surgeon, physiological status of patients. Many a time strict adherence to this 6 hour rule is not possible just based on the empiric evidence available in the literature.<sup>5,6</sup>

Open fractures are commonly complicated by infection, delayed union, mal-union and infected non-union. Infected non-union is very dreadful complication which is seen with extensive soft tissue loss as well as bone loss.<sup>1,5,6,7,8,</sup> Amputation used to be answer for the severely injured limbs in the past but in modern era of medical advancement such injuries are treated with free flap coverage, bone clearance and followed by fractional distraction osteoneogenesis using Ilizarov's fixation device which increase vascularity thus burning away infection and new healthy bone regeneration.<sup>9,10,11</sup>

**Aims and Objectives**

Aims and objectives of this study was to evaluate the outcome of external fixation devices while treating compound fractures of tibia, their role as definitive fixation device. Study specially aimed at salvaging limbs which earlier used to be amputated because of unsalvageable complication of infected gap non-union often seen in compound fractures of tibia.

**MATERIALS AND METHODS**

The said study was conducted at Christian Medical College Ludhiana in the department of Orthopaedics and with the backing of Department of Plastic and Micro vascular Surgery. 40 cases of various grades of compound fractures of tibia were treated and studied from June 1997 to May 1998 for the period of one year and followed up for two years before final analysis and recommendations.

**Karlstrom and Olerud Criteria of Results**

Criteria	Excellent	Good	Acceptable	Poor
Subjective symptoms around knee and ankle joint	0	Slight	Impairing Function	Impairing function Pain at rest
Working ability	Unimpaired	Slightly impaired	Walking distance restricted	Restricted distance with pain
Work and supports	Same before accident	Given up sports	Change to less strenuous work	Permanent disability
Angular/rotational Deformity	0	<10 degree	10-20 degree	>20 degree
Joint mobility loss	0	<10-degree knee <20-degree ankle	20-40-degree knee <40-degree ankle	>40 degree
Shortening	0	< 1 cm	cm	>3 cm

In our study all cases were classified according to Gustilo and Anderson classification of compound fractures which is worldwide accepted.

Grade	Description
I	Clean wound <1 cm
II	Moderately contaminated 1-10 cm wound
II-a	Contaminated wound, good bone coverage
II-b	Contaminated wound, skin, soft tissue and possible bone loss
III-c	Contaminated wound of any level with Arterial injury requiring repair

**Table 1. Gustilo and Anderson Classification of Compound Fractures**

All patients reporting to casualty department were immediately given generous saline and hydrogen peroxide lavage with at least 10 litres of saline and dressing with betadine-soaked gauzes before splint age and obtaining X-rays.

X-rays were obtained at time of admission, post operatively, every time any adjustment was done to fixator and on every follow up. All patients were taught how to clean the fixator, how to tighten pins, to advance rings in case of ring fixator at home.

Patients were allowed weight bearing with support as soon pain subsided. Initial fixation in all cases was on delta pattern or bi-planner for more stable fixation and early mobility. Complicated cases shifted to Ilizarov's fixator were managed on same pattern and immediate weight bearing was allowed. Physiotherapist assisted all patients while staying in hospital.

Infected pins were removed and replaced whenever needed and pin-tracts were over drilled, thoroughly debrided and dressed open for healing. Where ever required tubular fixator was replaced with Ilizarov's fixator for bone transportation and eradication of infection.

Final functional results were evaluated as per criteria proposed by Karlstrom and Olerud.

**Inclusion Criteria**

Patients with isolated compound fractures of tibia treated with external fixation devices only were included.

**Exclusion Criteria**

Patients of polytrauma, intercondylar fractures, requiring vascular repair, skeletally immature patients, previous same limb surgery, pre-existing infections, polio, etc., were excluded from study.

**RESULTS**

Among 40 patients under study, 36 (90%) were males and 24 (60%) were in age group of 20- 30 years. Frequency of involvement both sides were equal. 38 (95%) cases were victims of two-wheeler accidents. Most common level of fracture was middle third in 28 (70%) patients. Majority of patients belonged to Grade-II (26), followed by grade-IIa (11) and Grade-IIb (03) respectively.

Age in Year	Males	Females	Total	Percentage
20- 30	21	03	24	60.0%
31- 40	12	01	13	32.5%
41- 50	03	-	03	07.5%
Total	36	04	40	100%

**Table 2. Age and Sex Distribution**

Timing of surgery was within 12 hours in all cases which included initial lavage in causality with 10 litres of saline, beta dine soaked gauze dressing and splint age, followed by re- lavage in theatre with debridement and external fixator application. Primary closure was attempted in all patients with releasing incision in 30 patients, local rotation muscle flap was done in 7 patients and patients with Grade-IIb injury free flap surgery was done for wound coverage. All skin releasing incision wounds were skin grafted on appearance of granulation tissue. Secondary wound debridement was done in 7 patients and bone clearance and conversion to gap non-union in 3 cases.

Level of Fracture	Grade II	Grade III a	Grade III b	Total	%
Upper Third	06	01	-	07	17.5%
Middle Third	18	08	02	28	70.0%
Lower Third	02	02	01	05	12.5%
No. of Cases	26	11	03	40	100%

**Table 3. Level and Grade of Fracture**

Complications of pin tract infection in 8 cases, readjustment of fixator in 7 cases, osteomyelitis in case was observed. Fixator was removed between 10- 15 weeks in 18 (45%) cases out of them majority 16 (40%) were grade-II injuries, in 3 (7.5%) cases external fixator was kept for longer periods up to 35-40 weeks and these patients belonged to Grade-IIb who developed infected non-union and were managed by exchanging tubular fixator with Ilizarov’s ring fixator. In these cases, bone transportation was done and union with bone length was achieved.

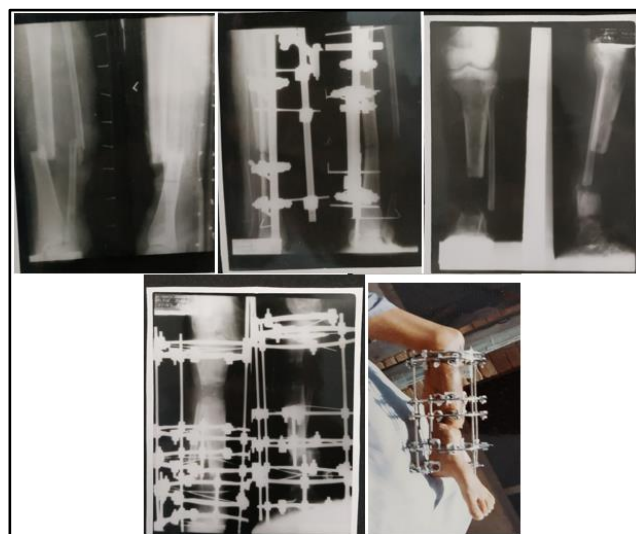
Fracture healing was observed in 18 (45.0%) within 11- 15 weeks. 11 (27.5%) cases in 16-20 weeks, 6 (15.0%) in 21-25 weeks, 2 (5.0%) cases in 31- 35 weeks and 1 (2.5%) case in 31-40 weeks respectively.

Union Time in Weeks	Grade-II	Grade-III a	Grade-III b	Total	%
11- 15	16	02	-	18	45.0%
16- 20	07	04	-	11	27.5%
21- 25	03	03	-	06	15.0%
26- 30	-	02	-	02	05.0%
31- 35	-	-	02	02	05.0%
36- 40	-	-	01	01	02.50%
Total Cases	26	11	03	40	100%

**Table 4. Time of Fracture Union**

Average surgeries per patients was 4.5 (3-10) however 13 (30%) had 3 surgeries each.

One at initial debridement and fixator application, at debunking of fixator/pin change and one at fixator removal, all these patients were of Grade-II injuries. Grade-III b patients had maximum surgeries as high as 8-10 in 3 (7.5%).



**Figure 1**

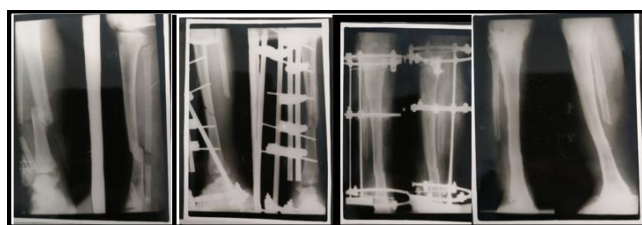
Case of 20 years boy with Grade-III b injury initially managed with wound debridement, external fixation having severe soft tissue deficiency developed infected nonunion, which was converted to gap non-union. Latter free latissimus dorsi flap coverage, shifting to Ilizarov’s ring fixator and bone transportation patient under-went 10 surgeries and finally fracture united in 40 weeks with acceptable result with no infection.

Results were accessed as per criteria proposed by Karlstrom and Olirud in terms of range of movement at knee and ankle, angulations, rotation, at fracture site, shortening and pain on walking etc. in spite of compound fracture, among 26 Grade II injuries, 20 (50.0%) had excellent results whereas 6 (15.0%) had good results with no acceptable and poor results.

Result	Grade-II	Grade-III a	Grade-III b	Total	%
Excellent	20	06	-	26	65.0%
Good	06	03	-	09	22.5%
Acceptable	-	02	03	05	12.5%
Poor	-	-	-	-	-

**Table 5. Results According to Karlstrom and Olerud Criteria**

Among 11 patients in Grade- III b injuries, 6 (15.0%) had excellent. 3 (7.5%) had good and 2 (05.0%) had acceptable results respectively, whereas all 3(7.5%) patients of Grade- III b group had acceptable results. None of our patient had poor results.



**Figure 2**

A case of 30years old male patient with Grade III-b injury developed osteomyelitis and soft tissue necrosis managed by flap coverage, conversion to Ilizarov's ring fixator and bone transportation. Patient under- went 8 surgeries and fracture united at 34 weeks with no infection and acceptable results.

**DISCUSSION**

Compound fractures of tibia pose a significant challenge due to its complications of soft tissue injury and loss, baring of bone and bone loss, infections, non-union, infected non-union.<sup>1,5,6,8,12</sup> Such cases are managed by early debridement, external fixation for alignment and stability or internal fixation with reamed or unreamed interlocking nailing with soft tissue coverage of bare bone by all means.<sup>3,13,14</sup> Each of these methods have their own merits and demerits. External fixator is a method choice of treatment in compound injuries whether used as definitive or temporarily.<sup>3,15</sup>

By stabilizing bone and soft tissue at distant place away from actual site of fracture, chances of infection is much less as compared to internal fixation devices.<sup>12</sup> Further risk of soft tissue injury and loss of blood supply is also less with external fixators.<sup>16,17,18</sup> There is risk of delayed union, malunion, infection, infected non-union etc because of nature of injury, soft tissue loss, bone loss, loss of blood supply and anatomical location and not only because of external fixator.<sup>17,18,19</sup> Many complications of fixator it- self like pin tract infection, pin loosening, breakage of construct etc can be easily managed by timely change of pin, introduction of new pin and frequently tightening of fixator.<sup>14,15,20</sup>

Internal fixation by plating compound fracture carries high risk of skin necrosis and more damage to periosteal

coverage and vascularity hence not recommended as primary procedure,<sup>21,22</sup> whereas nailing even unreamed causes damage to endosteal vascularity and carries risk of osteomyelitis.<sup>17,23</sup> Decision regarding nailing compound fracture should be taken depending upon various factors like timing of surgery and trauma, adequate soft tissue for bone coverage, low level of contamination, better health.<sup>20,24,25,26</sup> It is difficult to establish a guideline for nailing because of variable factors therefore external fixation is treatment of choice in all compound fractures till wound healing at least.<sup>8,17,24,25</sup>

Bhandari and associate<sup>27</sup> in a meta-analysis have reported that nail in comparison to fixator led fewer reoperations, less incidence of superficial infections and malunion. Henley et al in a study reported high rates of malunion in cases treated with external fixation.<sup>24</sup> Whittle et al on trial of unreamed Intramedullary nailing of open fracture of tibia reported infection rate of only 5% in Grade-IIIa and 25% in Grade-IIIb injuries, with 96% union rate with no malunion.<sup>25</sup>

Joshi et al concluded that unreamed interlocking nailing is safe option for Grade-I and Grade-II injuries even presenting late, use of unreamed nail in those Grade-III fractures with delayed presentation associated with high rate of complications. An adequate soft tissue management is mandatory in all these cases.<sup>26</sup>

Valazev and Flaming reported 12.5% delayed union,<sup>15</sup> Giannoudis et al reported 24% delayed union<sup>13</sup> where as Michail Beltrios et al reported 13.72% delayed union<sup>28</sup> respectively in their patients treated with external fixator as definitive treatment.

**CONCLUSION**

Our study concluded that outcome of treatment of compound fractures depend upon early presentation, shorter duration between injury to surgery, thorough debridement and lavage of wound, application of external fixator with delta configuration for more stability and adequate wound coverage by any means like relaxing incision and covering of main wound, local muscle flap rotation, free flap coverage etc. whichever is possible primarily or as staged procedures.

Weight bearing to be started as soon as pain becomes bearable with help of walking aids. Debunking of fixator to be done after radiological evidence of union. Pin tract infection if occurs should be treated by either removal of pin, over reaming and debridement, and should be left open to heal. Pin may be supplemented at another appropriate and healthy location if required. While managing compound fractures, number of surgeries are always more because of various complications. Various surgical procedures like skin grafting, re-adjustment of fixator, flap rotation, free flap coverage etc., are required.

Special thing in our study was converting infected non-unions to gap non-union, covering exposed fracture site with latissimus dorsi free flap coverage (by Plastic surgery Dept.), exchanging tubular fixator with Ilizarov's ring fixator and corticotomy with bone transportation. We were able to

salvage 3 limbs to satisfactory function because of its ability of fractional distraction histiogenesis or osteoneogenesis which not only attains adequate length of bone, but also brings abundant vascularity which eradicates the infection. This is a slightly lengthy and time-consuming method but very effective by virtue of which we were able to save 3 limbs with one good and two satisfactory levels of union with eradication of infection.

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