

## MANAGEMENT OF OPEN FRACTURE OF TIBIA DIAPHYSIS (GUSTILO-ANDERSON CLASSIFICATION TYPE-II AND ABOVE)

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**ABSTRACT: BACKGROUND:** Open tibia diaphysis fractures are complex injuries associated with a high incidence of soft tissue complications and union. Management of it varies with soft tissue and its outcome requires an aggressive approach towards patient along with revision surgery, so study was conducted to assess the outcome of closed proximal tibia fracture management. **AIM AND OBJECTIVES:** The study was conducted to assess the outcome of compound fractures of tibia managed by interlocking Intra-medullary nailing or External Fixator, to evaluate the incidence of complications and need for secondary procedures in these open fractures and to assess various factors/variables that may affect the outcome of such fractures when treated by these implants. **STUDY DESIGN:** Prospective type, **MATERIALS AND METHODS:** 50 consecutive closed tibial plateau fractures were included in this study. All fractures were classified according to Gustilo Anderson classification. There were 42 men and 8 women. The study was conducted between June 2009 and October 2011 at the Department of Orthopaedics, New Civil hospital, Surat after the Ethical committee approval. The final outcome was assessed using the Modified Ketenjian's Criteria. The results were analysed using different parameters; male vs. female, age distribution, mode of trauma, functional outcomes and complications etc. **RESULTS AND CONCLUSION:** The average age was 35.6 years with the fracture being more common in the 2<sup>nd</sup> to 5<sup>th</sup> decades. 90 % sustained fracture due to road traffic accident. The most common location of fracture was middle 3<sup>rd</sup> shaft of tibia (50%) and most common type was Open Grade 2 (52%) fracture according to Gustilo-Anderson classification. Patients treated by Interlocking nailing (n=33) group had high (90.9%) chances of union at final follow up, while only 70.58% of patients had union treated by external fixator group (n=17). Functional evaluation were assessed by modified Ketenjian's criteria, with results 28(56%) excellent, 10(20%) good, 5(10%) fair and 7(14%) poor results. Complication being infection(12), non-union(6), ant knee pain(6), delayed and mal union(4) and osteomyelitis(1).

**KEYWORDS:** Coronary Heart Disease (CHD), hs-CRP (high sensitivity C-Reactive Protein), diabetes mellitus, diabetes mellitus with hypertension, myocardial infarction

**INTRODUCTION:** Fractures of the Tibial shaft are the most common long bone fractures. There are about 26 Tibial diaphyseal fractures per 1,00,000 of the population per year.<sup>(1)</sup> The subcutaneous location of the anteromedial surface of the tibia leads to a high incidence of open fractures compared with other long bones. Approximately 23% of tibial diaphyseal fractures are compound fractures with majority being caused by vehicular accidents and high velocity trauma. In particular, for 'severe' lower limb injuries, the 'shin' region was identified as the most vulnerable area. The number of fractures affecting men is twice that affecting women. These fractures occurred mainly in younger people (under 40 years of age). Most bending fractures occurred in young men (20-30 yrs) and the torsion fractures affected men and women of about 40 equally. In older patients risk of tibial fracture

## ORIGINAL ARTICLE

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is not increased<sup>(2)</sup> because bone strength in torsion, which relates to third power of the bone diameter is not altered by bone resorption. Compound fractures are more prone to various complications of fracture healing like infection, delayed union/non-union. Various recommendations regarding these compound fracture management continue to be refined and redefined and management remains controversial including external fixator and interlocking nailing (reamed/unreamed). The introduction of small diameter, solid, unreamed tibia interlocking nails, has led to primary interlocking nailing in the open grade fractures.

**AIMS AND OBJECTIVE:** This study was conducted to assess the outcome of compound fractures of tibia managed by Unreamed/Reamed interlocking intramedullary nailing or External Fixator, to evaluate the incidence of complications and need for secondary procedures in these open fractures and to assess various factors/variables that may affect the outcome of such fractures when treated by these implants.

**MATERIAL AND METHODS:** This is a prospective type of study conducted at new civil hospital SURAT during the period of June 2009 to October 2011 after ethical committee approval. The study consist of 50 patients with open fractures of tibia operated either primarily or secondarily by tibia interlocking nail or external fixator, all the patients were treated as indoor patients. The inclusion criteria were patient of more than 15 year of age, open fracture of tibia diaphysis according to Gustilo Anderson classification<sup>(3)</sup> grade II grade IIIA, IIIB, IIIC and fracture above the 4cm of ankle joint. The exclusion criteria were patient less than <15 year of age and >70 year of age and who had bilateral tibia fractures.

On admission, all patients were managed according to ATLS protocol to start with. All patients were haemodynamically stabilized, thoroughly examined for other major associated injuries in head, thorax, abdomen or spine along with local limb examination including distal neurovascular status.

Primary thorough wound wash with copious amount of normal saline & antiseptic solution (POVIDONE IODINE +DILUTED H<sub>2</sub>O<sub>2</sub>) is done and a saline betadine pack is kept as a compound site as dressing. Priorly patients' IV line is taken and a crystalloid or a colloid including a blood transfusion if required is given. After giving proper splintage and traction reduction of the fracture the relevant x-rays are taken. Necessary analgesics, antibiotics (Amoxycillin-Clavulanic acid, Metronidazole, Gentamicin) and a shot of anti-tetanus serum (ATS) and anti-gas gangrene serum (AGGS) is given after negative test dose. After this primary treatment, urgent basic blood investigations are done and the preparation is made for the surgery. As per standard protocol at our institute these fractures are considered as emergency and the patient is posted for an emergency operation. Once anaesthetized, under regional anaesthesia reduction of the fracture is done with traction and open method along with help of image intensifier. Having confirmed about reduction painting, draping and isolation of the part of the done. Again a thorough wash of the compound wound with antiseptic solution (Cetrimide/povidone iodine) with copious amount of normal saline is done and the wound is properly debrided. Prophylactic antibiotic shot is given simultaneously. External fixator or intramedullary nail is then applied its configuration being dependent on the fracture pattern and the level of the fracture. The compound wound is left open for daily dressing but we have now been covering the wound primarily with split thickness skin graft or local primary flap after the procedure and above knee slab is applied and the patient is then shifted to the ward.

## ORIGINAL ARTICLE

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Postoperatively the limb was elevated on two pillows or Bohler's splint. Patient was encouraged to do active toe movements. Static quadriceps exercise and knee bending were started as soon as pain subsided. Parenteral broad spectrum antibiotics were given for 3 days. Analgesics were given as per needs and on second check dressing if the stitch line is clean then antibiotics are discarded, but if serous discharge present then swab taken from it and antibiotics were started according to culture/sensitivity report. Postoperative check X-rays were taken to see the position of implant and quality of reduction. Sutures were removed on 12<sup>th</sup> post-operative day and PTB cast was given. Patient was discharged with PTB cast and advised non weight bearing/partial weight bearing. Wounds of the open fractures were dressed regularly and as soon as local area was healthy. Wounds were covered with split thickness skin graft.

All patients were called for follow up after 6 weeks on follow up, thorough clinical examinations was done and check x-rays were taken to see the signs of union and position of implant. At 6 weeks, partial weight bearing was allowed depending on the progression of healing and associated injury with pair of axillary crutch or walker. At 10-12 weeks if signs of union were present clinically and radiologically patient was advised to bear full weight on affected limb PTB cast. If signs of union were not present at 10-12 weeks then dynamization was done by removing locking screws from the large fragment and patients was allowed for full weight bearing with PTB cast. On final follow up at 16-20 weeks depending on complete clinicoradiological union, unsupported full weight bearing was allowed. In absence of clinical and radiological signs of union, procedure like cancellous bone grafting with or without exchange nailing were done.

All the observations were recorded as per proforma. At final follow up, outcomes were assessed by Modified Ketenjian's Criteria<sup>(4)</sup> and rated as Excellent, Good, Fair or Poor based on pain, knee/ankle stiffness, swelling/deformity and gait of patient.

**OBSERVATION AND RESULTS:** Out of 50 patients, 33 patients were treated with primarily tibia interlocking nailing and other 17 were primarily debrided and external fixator were applied.

There is male preponderance in our series with the M:F ratio being 4:1.88% of patient with shaft tibia fracture were in the age group of 20-50 years. Youngest patient was 18 years of old. Oldest patient was 62 years of old. Mean age was 35.6 years. The most common mode of injury in the present series is road traffic accident (90%), remaining were due to fall (6%) and assault (4%). The delay in discharge was due to associated injuries or infection. The most common location of fracture was middle 3rd shaft of tibia (50%) and most common type was Open Grade 2(52%) fracture according to Gustilo-Anderson classification in current study. Second most common type was open type 3B which includes 34% (17) patients.

Additional surgery required were 17of 33 pt with interlocking nailing and all 17 pt with external fixator. All patients treated by external fixator required more aggressive and repeated surgeries in current study in the form of debridement, bone graft and flap and for interlocking nailing group was mainly in the form of dynamization & exchange nailing. 3 patients had ipsilateral shaft of femur, 2 had tibial plateau on opposite side, 3 opposite medial malleolus, 3 forearm bone, 1 shaft humerus, 1 talus and 2 had supracondylar femur fractures.

Functional evaluation of tibial fractures were assessed by modified Ketenjian's criteria.<sup>(4)</sup> Out of 50 open tibial fractures 28(56 %) excellent, 10(20%) good, 5(10%) fair and 7(14%) poor results, which are comparable with other studies.

## ORIGINAL ARTICLE

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Patients treated by Interlocking nailing group had high (90.9%) chances of union at final follow up, while only 70.58% of patients had union treated by external fixator group. For the non-union group revision surgery was conducted as mentioned in table. The patients treated by interlocking nailing had better full range of motion of both knee 31(93.93%) & ankle joints 32(96.96%) as compared to external fixator group, the main cause of which is found to be poor patient compliance, rigidity & bulkiness of the frame which discourages the patients to do joint mobilization. Two patients from the external fixator group had no range of motion, one had vascular injury who came with amputation later on and other had crush injury to foot.

One of the common complications encountered in open fracture was infection. The rate of infection was 24% (n=12) while Tornetta et al<sup>(5)</sup> 31% (n=9) and Kaftandziev et al<sup>(6)</sup> 39% (n=19) had infection. Infections were managed with suitable antibiotics and if required debridement. Other complications are mentioned in table along with comparison with other studies.

**DISCUSSION:** This is a study of management of open tibial diaphysial fractures involving 50 patients and followed up over a period of maximum 30 months. 33 patients were treated with primarily tibia interlocking nailing and other 17 were primarily debrided and external fixator were applied. Patients treated by Interlocking nailing group had high (90.9%) chances of union at final follow up, while only 56.25% of patients had union treated by external fixator group. Functional evaluation of tibial fractures were assessed by modified Ketenjian's criteria. Out of 50 open tibial fractures 28(56 %) excellent, 10(20%) good, 5(10%) fair and 7(14%) poor results. Thus 76% had good to excellent results which is lower than that reported by Joshi et al<sup>(7)</sup> (85.8% excellent to good) and Vineet Jain et al<sup>(8)</sup> (90% excellent to good). & Kaftandziev et al<sup>(6)</sup> (79.16% excellent to good). One patient with amputation, as discussed earlier is included in poor results. Poor functional outcome must have been because many of our patients were lost to follow up in intervening period and so vital time was lost for management of problems like nonunion and infection. Some of them have also refused for further management of nonunion and infection. Multiple articles have been published documenting functional outcomes of management of open tibial diaphysial fracture [Joshi et al,<sup>(7)</sup> Vineet Jain et al,<sup>(8)</sup> Kaftandziev et al,<sup>(6)</sup> Tornetta et al<sup>(5)</sup>]. The result and observation of the present study is compared with the other similar studies which are depicted in tables.

**CONCLUSION:** Though the series is relatively small and period of follow up is short, to draw the definitive conclusions however it appears that, all the compound III/B fractures of the tibia and fibula should be considered as surgical emergency. Stabilization of the patient, meticulous early debridement, fixation of the fracture with intramedullary nail or external fixator, early soft tissue coverage and prophylactic antibiotic therapy should be given preferably within the golden period. (6 hrs). The most important determinants of final functional outcome and complication rates are the initial soft tissue trauma and the amount of fracture comminution.

Interlocking nailing of open grade tibia fractures produce good functional outcomes with remarkably lower incidence of infection and other complications and is good treatment modality for these fractures. Dynamization of nails as well as bone grafting of fracture sites should be resorted to at earliest evidence of delay in union to avoid complications. External fixator frames provide acceptable stability for most of the compound fractures of tibia diaphysis and reasonable access to soft tissues for plastic coverage. Care of the limb treated with external fixation is essential.

## ORIGINAL ARTICLE

If on regular radiological assessment, union is not achieved then bone grafting should not be delayed. Bone grafting should be of cancellous variety. With all the above procedures, taking small but important cautious steps, we can try to achieve bony union and secondary procedure can be thus avoided.

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### REFERENCES:

1. Court Brown CM, McBirnie J. The epidemiology of tibial fractures. JBJS 1995; 77B: 417-421.
2. S B Naique, Management of severe open tibial fractures, JBJS Vol 88-B, No 3 March 2006.
3. J Orthop Trauma. 1993; 7(4): 357-60. Interobserver reliability in the Gustilo and Anderson classification of open fractures. Horn BD, Rettig ME.
4. Kayali C, H Agus, A Eren, and S Ozluk A retrospective comparative study between intramedullary nailing and biologic plating. Ulus Trauma Acil Cerrahi Derg, 2009 15.
5. Paul TORNETTA: Comparative study between external fixator & interlocking nailing JBJS.
6. Journal of Orthopaedic Trauma: September 2008 -Volume 22 -Issue 8 -pp 560-565 Operative Treatment of Ipsilateral Noncontiguous Unicondylar Tibial Plateau and Shaft Fractures: Combining Plates and Nails Kubiak, Erik N MD\*; Camuso, Matthew R MD.
7. Vineet Jain, Ayush Aggarwal, Primary unreamed intramedullary locked nailing in open fractures of tibia, IJO Jan 2005, Vol 39, No 1, P30-32.
8. Joshi D, Ahmed A, Krishna L, Lal Y. Unreamed interlocking nailing in open fractures of tibia.

Age	Incidence	Percentage
<20	1	2%
20-30	22	44%
30-40	15	30%
40-50	7	14%
>50	5	10%

**Table 1: Incidence of Age**

In our study of 50 patients with open tibial fractures, 44(88%) patients were in 20-50 years age group. Mean age of patients was 35.6 years which is comparable to Joshi et al<sup>(7)</sup> (30 years) and Vineet et al<sup>(8)</sup> (40.3 years).

Sex	Present Study		Vineet Jain et al <sup>(8)</sup>		Tornetta et al <sup>(5)</sup>	
	Male	Female	Male	Female	Male	Female
Incidence	42	8	37	3	20	9
Percentage	84	16	82.22	6.66	68.96	31.03

**Table 2: Sex**

## ORIGINAL ARTICLE

Cause	Present Study		Vineet Jain et al <sup>(8)</sup>		Joshi et al <sup>(7)</sup>	
	Incidence	Percentage	Incidence	Percentage	Incidence	Percentage
Assault	2	4	2	4.44	0	0
Fall	3	6	4	8.88	0	0
R.T.A.	45	90	39	87.5	100	100
Gunshot	0	0	0	0	0	0

Table 3: Mode of trauma

Gustilo & Anderson Grade(3)	Location						Total	Percentage
	U/3	U/3-m/3	M/3	M/3-l/3	L/3	Segmental		
GRADE II	0	4	15	6	4	0	26	52%
GRADE IIIA	0	1	3	1	0	3	6	12%
GRADE IIIB	2	1	7	1	1	0	17	34%
GRADE IIIC	1	0	0	1	0	0	1	2%
<b>TOTAL</b>	<b>3</b>	<b>6</b>	<b>25</b>	<b>8</b>	<b>5</b>	<b>3</b>	<b>50</b>	<b>100%</b>

Table 4: Type & Location of fracture

The majority of patients had OTA TYPE C 58%(29) fractures, out of which TYPE C3 subgroup was the commonest 26%(13) which denotes high velocity trauma and severe bone comminution in current study. Other 16%(8) had OTA TYPE A and 26%(13) of patients had OTA TYPE B which indicates less severe mode of trauma as compared to OTA TYPE C.

Treatment	Numbers of patient	Percentage
Interlocking nailing	33	66%
External fixator	17	34%

Table 5: Modality of treatment

Surgery	Incidence	Percentage
Suturing	16	32
Flap	10	20
STG	17	34
Flap+STG	7	7
Vascular repair	1	1
Debridement	6	12

Table 6: types of secondary surgery for wound coverage

## ORIGINAL ARTICLE

Most of the patients treated by Ex.fixator usually requires soft tissue coverage in the form of flap or S.T.G. Type of flaps includes free flaps, sural artery island flap, posterior tibial perforator flap, posterior tibial flap, reverse soleus flap for lower third leg; soleus & free flap for middle third leg & gastrocnemius muscle, anterior tibial perforator & free flap for upper third leg. One patient required vascular surgery, but as it is not done in our institute, patient was referred to higher centre. This patient was not included in the study but came later on with below knee amputation.

Types of Revision Surgery	Incidence	Percentage (%)
Dynamization	8	16
Bone graft	2	4
Ilizarov	1	2
Ex.nailing/OR+IF	3	6

**Table 7: Types of revision surgery to achieve bony union**

All patients treated by external fixator required more aggressive and repeated surgeries in current study in the form of debridement, bone graft and flap. Additional surgery for the interlocking nailing group was mainly in the form of dynamization & exchange nailing. These mostly included open type 3B and 3C according to Gustilo-Anderson classification.

Complication	Present Study		Tornetta et al <sup>(5)</sup>		Kaftandziev et al <sup>(6)</sup>	
	Incidence	Percentage	Incidence	Percentage	Incidence	Percentage
Infection	12	24	9	31.03	19	39.58
Non union	6	12	0	0	6	12.5
Delayed union	2	4	2	6.89	0	0
Mal union	2	4	2	6.89	2	4.16
Ant. Knee pain	6	12	1	3.44	4	8.33
Osteomyelitis	1	2	0	0	1	2.08
Screw breakage	1	2	0	0	2	4.16

**Table 8: Complications**

	Excellent	Good	Fair	Poor
Interlocking nail	20	8	3	2
External fixator	8	2	2	5
<b>Total</b>	<b>28</b>	<b>10</b>	<b>5</b>	<b>7</b>
<b>Percentage</b>	<b>56</b>	<b>20</b>	<b>10</b>	<b>14</b>

**Table 9: Modality of Treatment & Functional Outcome**

Current study shows that patient treated by interlocking nailing group shows more chances of excellent to good result as compared to external fixator.

## ORIGINAL ARTICLE

	Excellent	Good	Fair	Poor
No. of patient	28	10	5	7
Percentage	56%	20%	10%	14%

**Table 10: Functional outcome according to Modified Ketenjian's Criteria<sup>(3)</sup>**

Study shows 56% of excellent result which includes no notable abnormality without any pain,swelling, limp with normal full range of motion.

	Complication	Functional outcome	
Nail dia.	Nail+screw Breakage	Excellent+good	Fair+poor
8mm.(n=2)	50% <sup>(1)</sup>	50% <sup>(1)</sup>	50% <sup>(1)</sup>
9mm.(n=18)	0%	78% <sup>(14)</sup>	22% <sup>(4)</sup>
10mm.(n=13)	0%	76.92% <sup>(10)</sup>	23.08% <sup>(3)</sup>

**Table 11: Impact of Nail Diameter on complications & functional outcome**

Patients operated by Nail diameter of 9 and 10 mm had better functional outcome. No nail breakage was observed in current study. 8 mm diameter nail was used in only 2 patients, out of them 1(50%) had screw breakage.

Working length (cms)	% of second procedures	% complications	Functional outcome			
			Excellent	Good	Fair	Poor
0-10(9)	11.11%	22.22%	77.78%	22.22%	0%	0%
10-20(16)	35%	36.36%	62.50%	38.50%	0%	0%
20-30(8)	45.45%	44.8%	25%	37.50%	22.50%	5%

**Table 12: Incidence of Working Length & Functional Outcome**

Shorter working lengths were associated with higher rates of excellent and good results and lower rates of secondary procedures while longer working lengths were associated with lower rates of excellent results and higher rates of secondary procedures and complications.

Joint	Range of motion	Ex.fixator	Interlocking Nailing
Knee	FULL	7(41.17%)	31(93.93%)
	PARTIAL	8(47.05%)	2(7.09%)
Ankle	FULL	10(58.82%)	32(96.96%)
	PARTIAL	7(41.17%)	1(3.03%)

**Table 13: Range Of Motion of Joints at Final Follow Up**

The patients treated by interlocking nailing group had more nu. Of patients with full range of motion of both knee 31(93.93%) & ankle joints 32(96.96%) as compared to external fixator group,



## ORIGINAL ARTICLE

the main cause of which is found to be poor patient compliance, rigidity & bulkiness of the frame which discourages the patients to do joint mobilization. Two patients from the external fixator group had no range of motion, one had vascular injury who came with amputation later on and other had crush injury to foot. Full range of movements included 0-130° at knee joint & 0-20° Dorsiflexion with 0-50° Planter flexion, 0-25° Eversion, 0-35° Inversion of ankle joint.

Time interval	Time to FWBW	Time to union	Number of secondary procedure	Compli-cations	Infection	Functional outcome	Fair + poor
	(weeks)	(weeks)		Delayed union		Excellent + good	
Time to 1st RX							
<6hr(42)	22.2	23.7	26%(11)	7.14%(3)	7.14%(3)	84.78% (36)	15.22%(6)
>6hr(8)	29.1	28	57.14%(4)	37.5%(3)	37.5%(3)	14.29%(1)	85.71%(7)
Time to 1st SX							
<24hr(39)	24.2	25.7	66.66% (26)	27.9%(11)	12.82% (5)	86.05% (34)	13.95%(5)
>24hr(11)	23.1	24.5	54.54% (6)	29.4%(3)	36.36% (4)	17.47%(2)	82.53%(9)

Table 14: impact of time to first treatment and surgery

The final Functional outcome, time to Full Weight Bearing Walking (FWBW), time to Clinical Union were dependent on the time interval to first treatment (Trauma-Treatment interval) and on the time interval to first surgery (Trauma-Surgery interval). Those patients that had a delay (>6hr) in primary treatment & delay (>24 hrs) in primary surgery showed increased rates of infection, non union and increased need for secondary procedures, longer time for full weight bear & final union.

## ORIGINAL ARTICLE

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