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Primary Nailing of Type-I and II (Gustilo – Anderson) Open Fracture of Tibia After 6 Hours of Injury

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Abstract: ***Background :-*** *Primary nailing of open fracture of tibia after 6 hours of injury is a controversial issue. Conventionally open fractures are debrided and fixed with external fixator or nail as an urgent case.* ***Objectives :-*** *The purpose of this study is to evaluate the result of reamed locked intramedullary nailing of type-I and II (Giustilo – Anderson) open fracture of shaft of tibia when it is performed after 6 hours of injury.* ***Methods :-*** *30 patients with type-I and II open fracture of shaft of tibia between the ages of 18 and 50 years were included. On arrival, wound lavage was given in emergency minor OT and antibiotic was started. Primary nailing was done as an elective case in routine operation theatre. Results were evaluated with Ekeland et al criteria.* ***Results :-*** *24(80%), 4(13.3%) and 2(6.6%) cases were rated as excellent, good and fair. None was rated as poor. 3(18.75%) out of 16 type-II fracture got deep infection. None of the 14 type-I fracture got infected. Infected cases got union without any further surgical intervention.* ***Conclusion :-*** *Primary nailing of type-I and II open fracture of tibia after 6 hours of inury gives excellent outcome in 80% of cases, but the rate of infection in type-II open fracture is high.*

Keywords – *Open fracture tibia, Intramedullary nailing, Ekeland criteria.*

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I. Introduction

Timing of initial debridement is one of the most debated controversies with regard to the initial management of open fracture[1]. It becomes a tradition to teach every resident to debride wound before 6 hours. The so called "6 hour rule" of debridement probably originated from the finding of a German surgeon Friderich in 1898, in which guinea pig with contaminated soft tissue wounds had lower rates of infection when debridement was performed within 6 hours[2]. Several studies have shown the risk of infection is not increased when the debridement is delayed more than 6 hours[3-10]. But the delayed admission to the definitive treating trauma centre was associated with increased risk of infection[11]. Patzakis and Wilkins reviewed more than 1000 open fracture and concluded that most important factor in reducing infection was early administration of antibiotics and patients who got antibiotic earlier than 3 hours has less risk of infection[12].

Regarding debridement, several authors have questioned the need for surgical debridement of type-I open fracture[13-15]. Yang and Eisler reported 0% of infection rate in type-I open fractures which were treated conservatively without debridement[13]. There is no debate over the need of surgical debridement of type-II and III open fractures. Traditionally empirical antibiotic prophylaxis involves use of mono therapy with first generation cephalosporin for type-I and addition of aminoglycoside for higher grade.

After review of 49 studies, Grotes et al recommended coverage of gram positive in all types of open fracture and addition of gram negative coverage in type-II open fracture[16]. Type-I and II compound fractures can be treated with primary nailing or conversion to intramedullary nail from external fixators. Conversion to nail is associated with deep infection, most important source being pin sit infection [17-18]. Primary nailing is well studied but a limited number of publications on delayed primary nailing of open tibia fracture is available[19-23].

In developing countries, surgery is delayed due to various reasons, particularly due to inadequate infrastructure. The purpose of the present study is to evaluate the result of reamed interlocking nail in type-I and II open fracture of shaft of tibia when it is performed after 6 hours of injury.

II. Materials And method

Thirty (30) consecutive patients with type-I and type-II (Gustilo – Anderson classification) open fracture of shaft of tibia with or without fibula fracture, who were treated with primary nailing after a delay of more than 6 hours from the time of injury were included. Injury to surgery interval was measured from the time of injury to starting of operation and rounded to the nearest hours.

2.1 Inclusion Criteria

1. Fracture of shaft of tibia i.e 4cm distal to tibial tuberosity to 4cm proximal to ankle
2. Age group – 18 to 50 years.
3. Type-I and type-II open fractures.
4. Injury to surgery interval more than 6 hours.

2.2 Exclusion criteria

1. Type-III open fractures.
2. Fracture pattern which is not suitable for intramedullary nailing.
3. Fracture with severe contamination like farm yard injury.
4. Immunocompromised patient – patient with HIV, patient on steroid.
5. Patient with any medical condition which is associated with increase risk of infection – diabetes mellitus, peripheral vascular disease, hypoalbuminia (< 3.5gm/dl)

2.3 Age incidence

Age (in years)	*Number of patients*	*%*	*Mean age*
11 – 20	1	3.3	32
21 – 30	14	46.6	
31 – 40	12	40	
41 – 50	3	10	

2.4 Sex incidence

Gender	*Number of patients*	*%*
Male	22	73.3
Female	8	26.6

2.5 Gustilo – Anderson type

Type	*Number of patients*	*%*
Type-I	14	46.6
Type-II	16	53.3

2.6 Anatomy of fracture

Type	*Number of patients*	*%*
Transverse	8	26.6
Short oblique	16	53.3
Comminuted	6	20

2.7 Site of fracture

Site	*Number of patients*	*%*
Proximal 1/3	2	6.6
Middle 1/3	14	46.6
Distal 1/3	14	46.6

2.8 Mode of injury

Mode	*Number of patients*	*%*
Road traffic accident	24	80
Fall from height	4	13.3
Sports injury	2	6.6

2.9 Pre – operative treatment protocol

Patients were examined in detail. Intravenous antibiotic, cefuroxime 750 mg with sulbactum 375 mg was given in type-I fracture. Amikacin 500 mg was added in type-II fracture and continued 12 hourly. Tetanus prophylaxis with anti-tetanus serum was given. Washing of the wound was done in emergency minor OT with plenty of normal saline and povidone iodine solution. Pushing of fluid with pressure either with syringe or pulsatile lavage was avoided. Wound was covered with dressing pads soaked with povidone iodine solution. Plaster of paris slab was given and X-ray was taken. After this primary care, patients were operated as an elective case.

2.10 Operative procedure

Operations were performed under spinal or epidural anaesthesia without tourniquet. No formal debridement was done in type-I open fracture. Formal debridement was done in type-II open fractures at the time of nailing. It was followed by change of draping and instruments before the performance of actual nailing. Patient was kept in supine position on a table which can be folded at knee level when require manipulation was done to reduce the fracture. If the wound is large enough, direct reduction was done. Patellar tendon splitting approach was used. Guide wire was passed and position was checked with C-arm. Reaming was done using flexible reamer. Nail size was 1mm smaller than last reamer size. Locking was first tried with a jig and free hand technique was used when this failed. Distal locking was done first. When the fracture was axially stable, only the dynamic hole was locked. Wound was closed with suction drain. Antibiotic was continued for 5 to 10 days depending on the wound condition.

Partial weight bearing was started within 1 or 2 weeks. Dynamisations was done at 10 to 12 weeks, if union was not satisfactory. Patients were followed up at an interval of 4 weeks till fracture got union then at 12 months and 24 months. Final overall outcome was assessed using criteria of Ekeland et al, which consider malalignment , range of motion of knee and ankle, pain, swelling and duration of union[23,25].

III. Results

The mean interval between injury and presentation at hospital was 3.7 hours (range 1 to 8 hours). The mean of injury to surgery interval was 35.7 hours (range 12 to 50 hours) and details is shown in table-2. 8, 9 and 10 mm nails were used in 2 (6.6%), 24 (80%) and 4 (13%) patients respectively. 18 (60%) were dynamically locked, 12 (40%) were statically locked. Wound was closed in all patients. Average duration of hospitalization was 14.6 days (range 8 to 18 days). Average union time of type-I open fracture was 19.7 weeks (range 16 to 28 weeks) and that of type-II fracture was 23.75 weeks (range 20 to 36 weeks). Overall final outcome is shown in table-4. Complications are shown in table-3. 3 (18.75%) patients of 16 type-II fractures had deep infections. Klebsiella pneumonia was grown in 2 cases and pseudomonas aeruginosa in one case. Fixation was stable in all the 3 cases and it was retained till union. One got union at 28 weeks and other two at 36 weeks. Knee ROM was not restricted in any case. 6 (20%) patients had dorsiflexion less than 20° and plantar flexion less than 30°.

Table-1: Ekeland et al criteria for assessing final outcome

	Excellent	*Good*	*Fair*	*Poor*
I. Malalignment				
1. Varus or valgus	5	10	15	>15
2. Antecurvatum or recurvatum	5	10	15	>15
3. Internal rotation	5	10	15	>15
4. External rotation	10	15	20	>20
5. Shortening	1cm	2cm	3cm	>3cm
II. Range of knee motion				
1. Flexion	>120	120	90	<90
2. Extension deficit	5	10	15	>15

III. Range of ankle motion				
1. Dorsiflexion	>20	20	10	<10
2. Plantar flexion	>30	30	20	<20
IV. Pain	None	Sporadic	Significant	Severe
V. Swelling	None	Minor	Significant	Severe
VI. Duration for union				
1. Gustilo type-I open fracture	<20 weeks	21-24	25-28	>28 weeks
2. Type-II open fracture	<24 weeks	25-28	29-32	>32 weeks

Table-2: Injury to surgery interval

Injury to surgery interval (in hours)	*Number of patients*	*%*
6 – 24	8	26.7
25 – 48	20	66.7
49 – 72	2	6.6

Table-3: Complications

Complications	*Number of patients*	*%*
I. Deep infection in type-I	0	0
II. Deep infection in type-II	3	18.75
III. Minor soft tissue complications		
Type-I	0	0
Type-II	6	37.5
IV. Compartment syndrome	0	0
V. Anterior knee pain	6	20
VI. Non union	0	0

Table-4: Final outcome, assessed with Ekeland et al criteria

Grade	*Number of patients*	*%*
Excellent	24	80
Good	4	13.3
Fair	2	6.6
Poor	0	0

Table-5: Comparisons of some selected studies

study	***Total no. of patient***	***Gustilo-Anderson type and no. of patient***	***Injury to surgery interval in hours (range)***	***Average union time in weeks with type***	***Infection with type No. of patient (%)***	***Non union No. of patients***
Present	30	I - 14 II - 16	35.7 (12-50)	I – 19.7 II – 23.75	I – 0 II – 3 (18.75%)	0
Srinivas P et al[23]	44	I – 15 II – 19 III - 10	6 (2-8)	I – 26 II – 29	I – 0 II – 2(10.5%)	0
Kumar A et al[22]	28	I, II	14.54 ± 6.304 (Mean ± SD)	15.43 ± 3.72 (Mean ± SD)	3.57%	0
Djahan giri A et al[26]	26	I – 15 II - 11	24 (4 – 48)	18 (13 – 46)	I – 0 II – 2 (18%)	2
Aggarwal A et al[21]	30	I, II, III	< 8 in 10 patients 8-48 in 20 patients	I – 16 II – 18.3	I – 0 II – 0 III - 3	I & II – 0 III – 1
Aliduo T et al[27]	63	_	48 (1 to 20 days)	7 months	11 (17.5%)	2
Kamat AS[4]	41	I – 30 II - 11	9.15 (6.15-17.25)	-	5 (12.1%)	-

Table-6: Comparisons of final outcome

Study	*Number of patients (%)*			
	Excellent	*Good*	*Fair*	*Poor*
Present	24 (80%)	4 (13.3%)	2 (6.6%)	0
Srinivas et at[25]	39 (89%)	4 (9%)	-	1 (2%)

Fig.1: X-ray in AP & lateral view showing fracture both bone distal 1/3rd

Fig.2: Post-operative X-ray in AP & lateral view showing locking IM nail fixation of distal tibia fracture

Fig.3: X-ray in AP & lateral view showing locking IM nail fixation of mid 1/3rd fracture of tibia

Fig.4: X-ray in AP & lateral view showing locking IM nail fixation of proximal 1/3rd fracture of tibia

Fig.5: Showing type-I open fracture of tibia after healing of wound

IV. Discussions

Primary nailing of open fracture of tibia after 6 hours is a dilemma. Due to inadequate infrastructure, surgery is delayed in many areas of developing countries. Conversion to locked intramedullary nailing from external fixation also carries the risk of infection.

Yokoyama et al reported 16.7% deep infection after conversion to intramedullary nail from external fixators[17]. When the patient is operated after 6 hours due to some reason, the question is whether to treat all these patients with external fixators in the conventional way or to do primary intramedullary nailing. Comparisons of injury to surgery interval and associated result are shown in table-5. If nailing is done in type-I fracture after 6 hours of injury, there may not be any risk of infection as most of these study in table-5 shows zero infection rates. It is safe to nail type-I open fracture tibia after 6 hours of injury with antibiotic prophylaxis.

Infection in type-II ranged from zero in Agrawal et al series to 18.75% in the present study[28]. 18.75% of the present study can be considered as a high incidence. But comparable to 16.7% of Yokoyama et al series, of conversion to nail from external fixators[17]. Growth of gram negative organism showed that the most probable source of infection was hospital acquired. Publications on primary nailing after 6 hours are a few and sample sizes are small to draw a definitive conclusion. Average time of union of the present study is comparable to that of most of the studies

Srinivas P et al series took longer time[25]. Non union was rare in type-I and II fracture in all the series shown in table-5 and there was no case of non union in our series. Comparison of final outcome using Ekeland et al criteria, with that of Srinivas P et al is shown in table-6[25]. More than 90% had either excellent or good result in both the series.

V. Conclusion

Primary locked intramedullary nailing of type-I and II open fracture of tibia after 6 hours of injury is a safe procedure. It gives excellent result in 80% of cases and infection rate in type-I open fracture is zero and in type-II open fracture is 18.5% which is on the high side.

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