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Prospective Study of Results in Open Tibia Diaphyseal Fractures Treated By Unreamed Solid Interlocking Nail

[1*]Dr. Ashwini Gaurav, [2]Dr. Prabhat Agrawal, [3]Dr. Ranjit Kumar Singh, [4]Dr. Marut Nandan Kumar, [5]Dr. Gunjan Sahaj Ramani

[1]*Senior Resident, Patna Medical College and Hospital, Patna*
[2]*Senior Resident, All India Institute Medical sciences, New Delhi*
[3]*Associate Professor, Patna Medical College and Hospital, Patna*
[4]*Assistant Professor, Patna Medical College and Hospital, Patna*
[5]*Consultant, Holy FamilyHospital, Kurji, Patna*
Corresponding Author:[*]Dr. Ashwini Gaurav,

Abstract

Introduction: *Open simple diaphyseal tibial fracturesare common cases in every hospital and a variety of implants have been used for managing it. We study the results of unreamed solid interlocking nail as a primary treatment in such fractures.*

Material and Methods: *40 cases of open simple diaphyseal tibial fractureswere followed up for 1 year. All of these cases were treated by undreamed solid interlocking nail at Patna Medical College& Hospital, Patna. All the patients were classified by Gustilo Anderson classification and the primary surgery done by the above method. Coverage was done by plastic team in all demanding cases. At final follow up, outcomes were assessed by ModifiedKetenjian's Criteria and rated as excellent, good, fairand poor based on pain, knee/ankle stiffness, swelling /deformity and gait of patient.*

Results: *We had more cases of male patients than females (82.5% vs. 17.5%) in the age group range of 20 to 46 years (Average 32.17). Road traffic accident was the most common cause in our study (87.5%). Gustilo & Anderson classification was used and 47.5% were grade I, 25% were grade II and 27.5% were grade III. Operative time, time to full weight bearing and time to union increased in each group progressing from grade I to grade IIIB. Average time to union was 23 weeks. Primary closure of skin was successfully done in 85% of cases, while 15% required secondary surgery such as skin graft and flaps. Complications such as delayed union (22.5%), superficial infection (12.5%), Knee stiffness (15%), screw breakage (5%) and infected nonunion (10%) were encountered with maximum occurrence in grade III fractures. Final outcome was accessed by Modified Ketenjian's Criteria and was good to excellent in 72.5% cases and poor in 10% cases. Grade I & II had better results than grade III.*

Conclusion: *It was concluded that results of unreamed solid interlocking nail was good in grade I & II open fractures of tibial diaphysis and should be used cautiously in grade III fractures.*

I. Introduction

Tibia diaphyseal fractures are the most common long bone fractures[1]. It has always been a case of repeated deliberation among surgeons because of the frequentness of the fracture and also the problematic thin soft tissue envelope around it. There is high incidence of open injuries in this region and around 23% of all tibial fractures are open[1]. Complications such as infection or non-union often lead to unemployment and other socio economic problems. Several studies have been published in the past on the methods of treatment (vallier[2, 3]). External fixation, plating and nailing are the well-established methods of treatment and all have been associated with various specific complications. External fixation is usually used as a temporary method of stabilization in open fractures and is usually followed by a second procedure. Prolonged healing time and pin tract infections are commonly associated problems (Emami[4], Helland[5]). Plating frequently leads to infection, skin dehiscence and implant prominence (joveniaux[6]). Whereas, nailing has been associated with malalignment and knee pain(Larsen[7,]Salem[8]).

Reaming for intra medullary nail has generally been contraindicated as theoretically it increases the risk of infection and non-union by damage to the endosteal blood supply while reaming. And thus unreamed nails have been suggested as a safer procedure (Keating[9]). The purpose of our study has been to assess the results of open simple tibia diaphyseal fractures that were treated by unreamed interlocking nail as a primary mode of treatment.

II. Material And Methods

All the cases were studied during April 2012 to January 2016. 40 cases of open simple diaphyseal tibial fractures were treated at our institute with unreamed solid interlocking nail and followed up to 1 year. Inclusion criteria:opensimple diaphyseal fractures of tibial shaft (Gustilo Anderson classification grade I to III B) presenting within 6 hours of injury were included in the study. Exclusion criteria: gradeIIIC open tibial shaft fractures, openphysis, segmental and comminuted fractures, polytrauma patients, patients presenting late than 6 hoursand fractures extending to 5 cm near to proximal or distal articular surface were excluded.

All patients were managed according to standard ATLS protocol. After vital stabilization, wounds were lavaged with copious amount of normal saline and a primary debridement was done under anaesthesia in the emergency. The fracture was next classified according to Gustilo Anderson classification and a temporary splintagedone. The patients were then taken for definitivefixation either on same day or next day by asolid unreamed stainless steel interlocking nail in the elective operation theatre as per the availability of senior author. Injectable antibiotics were started in the emergency and were continued until the stitch removal after which oral antibiotics were advised for 2 weeks.

Those fractures requiring wound coverage after the fixation were transferred immediately to plastic surgery department where all the secondary procedures were completed within maximum 3 weeks.

The Range ofmotion exercises were started from the next very day and was advised physiotherapy for the next 2 weeks after discharge. Partial weight bearing was started at the earliest radiological sign of callus formation usually at 4 weeks and was gradually transformed to full weight bearing over a month as the callus progressed. All patients were followed up at 6 weeks for the first 6 months and then every 3 months up to 1 year. At every follow up all the patients were clinically and radiologically evaluated. Any complication was noted and appropriate advice was given. Union was confirmed if the fracture showed solid bridging callus in two orthogonal X-ray views and was devoid of any pain or tenderness at fracture site (Blachut[10], Corrales[11], and Sledge[12]). Fractures not showing union between 24 and 36 weeks were considered delayed union (campanacci[13], weissman[14]) and fractures not united at 9 months with no sign of progression of union for last 3 months both clinically and radiologically were considered non-union (Blachut[10]). Final follow up was done at one year and the outcome was assessed by Modified Ketenjian's criteria[15] and rated as excellent, good, fair or poor.

Modified Ketenjian's Criteria:Excellent - No notable abnormality; **GOOD**-Occasional pain with prolonged use,joint motion 75% of normal, trivial swelling, normal gait; **FAIR** -Pain with ordinary activity, joint motion 50% of normal, small amount of swelling, slight limp; **POOR** -Constant pain, joint motion less than 50% of normal, any visible deformity, limp, gait on cane or crutches.

Results

Total Cases		40			
Male		33 (82.5%)			
Female		7 (17.5%)			
Average Age (Years)		32.17		20 – 46 Range	
Cause Of Trauma		RTA (87.5%) Fall From Height (7.5%) Assault (5%)			
Surgical Delay (Hours)		11.275		6 – 24 Hours	
Gustilo & Anderson	**Average**	**I**	**Ii**	**Iii A**	**Iii B**
Total Cases	40 (100%)	19 (47.5%)	10 (25%)	7 (17.5%)	4 (10%)
Operative Time (Minutes)	62.87 (40-100)	52.89	62	76.42	88.75
Time To Full Weight Bearing (Weeks)	9.69 (8-12)	9.1	10	10.66	12
Time To Union (Weeks)	23 (18-30)	21.94	23.8	25	24
Primary Closure Of Skin	34 (85%)	100 %	100 %	71.5%	0 %
Secondary Closure (Graft/ Flaps)	6 (15%)	0 %	0 %	28.5%	100 %
Complications	**Total**				
Delayed Union	9 (22.5%)	3 (15.7%)	4 (40%)	2 (28.5%)	0
Superficial Infection	5 (12.5%)	0	1 (10%)	1 (14.2%)	3 (75%)
Stiff Knee	6 (15%)	0	0	2 (28.5 %)	4 (100%)
Nail Breakage	0	0	0	0	0
Screw Breakage	2 (5%)	2 (10.5%)	0	0	0
Infected Non Union	4 (10%)	0	0	1 (14.2%)	3 (75%)
Modified Ketenjian's Criteria					
Excellent	21 (52.5%)	17 89.4%)	3 (30%)	1 (14.3%)	0
Good	8 (20%)	1 (5.3%)	4 (40%)	3 (42.8%)	0

Fair	7 (17.5)	1 (5.3%)	3 (30%)	2 (28.6%)	1 (25%)
Poor	4 (10%)	0	0	1 (14.3%)	3 (75%)

III. Discussions

In our study of 40 cases of opentibia diaphyseal fractures seen in young aged male patients with an mean age of 32.17 years comparable to whittle et al (34 years) and Joshi et al[16] (30 years). In our study, majority of the fractures were due to Road traffic accidents (87.5%), while 7.5% were due to fall from height and 5% due to assault comparable to previous studies[16, 17, 18].The patients after admission were usually posted for surgery same day;few cases were delayed due to hospital constraints such as medical fitness or availability of senior surgeon. Average waiting duration for surgery was 11.27 hours (Range 6 – 24 hours).The average duration of surgery was 62.87 minutes ranging from 40 minutes for grade I transverse fractures to 100 minutes for grade III B fractures. Average time was 52.8 min for grade I, 62 min for grade II, 76.42 min for grade IIIA and 88.75 min for IIIB. Time duration increased with the grading of fracture. Primary closure of wound was successfully done in 85% of cases and 15% required secondary closure procedures such as grafts and flaps. This was comparable to results of 70.02% cases of Yokoyama[15] et al and 70% of Leong[19] et al. Immediate adequate debridement under anaesthesia followed by tension less suturing has been favored by many surgeons and was followed at our center.

Partial weight bearing was usually started around 4 weeks when the fracture showed signs of early callus formation. Full weight bearing was reserved for another 4 weeks when circumferential callus formation could be appreciated in X-rays. Average time to full weight bearing was 9.69 weeks ranging from 8 to 12 weeks. Severity of Soft tissue and fracture comminution were the main factors for delayed weight bearing. Grade I fractures were full weight bearing by 9.1 weeks, grade II by 10 weeks, grade IIIA by 10.66 weeks and IIIB by 12 weeks. Average time to union in our study was 23 weeks ranging from 18 to 30 weeks. Grade I fractures United at an average of 21.94 weeks, grade II by 23.8 weeks, grade IIIA by 25 weeks and only one case of grade IIIB fracture United at 24 weeks. So we notice that severity in compound grading increased the time to full weight bearing as well as time and rate of union in our study.

The complications observed in our study were superficial infections in 12.5%, knee stiffness in 15%, and screw breakage in 5% and infected non-unions in 10%. Superficial infection was reported as 12.5% in our study. Grade I types had 0%, grade II had 10%, grade IIIA had 14.2% and grade IIIB had 75% superficial infections. These infections usually cleared in all grades by a short course of oral antibiotics, except, in IIIB cases where 50% progressed to deep infection and non-union. This rate was comparable to the study by agrawal[20] et al at 10% all of which were in grade III cases. Gustilo and Anderson[21] also reported at 2-16% infection rates in their study.

Knee stiffness was reported at 15% in our study and all of the cases were in grade IIIA and IIIB cases. Joshi[16] et al reported an incidence of 14.3% in a similar study. Severe soft tissue injury requiring secondary closure procedures required prolonged immobilization which leads to more number of stiff knee cases.

There were 2 cases (5%) of distal locking screw breakage in ours study. There were no cases of nail breakage. This was very less as compared to rates of Joshi[16] et al (14.3%) and Keating[9] et al (29%). The expected reason could be that we have used 9mm nail in most of our cases, than the 8mm nails which allow small diameter screws only, and, that we delayed the complete weight bearing until confirmation of bridging callus on radiographs.There were 15.7% cases of delayed union among grade I, 40% among grade II and 28.5% among grade IIIA fractures. These were more common in grade II and III fractures (66.6%).

Non-union rate in our study was 10% average as compared to 4% cases by whittle[17] et al, 21.42% by Joshi[16] et al and 10% by Vineet[18] et al. All the cases were among grade III fractures. Thus, extensive soft tissue damage always leads to poor union rates in our study. The overall results were assessed at the end of 1 year by modified Ketenjian's criteria[15], and, were excellent in 52.5% cases, good in 20% cases, fair in 17.5% cases and poor in 10% cases. Joshi[16] et al reported 85% good to excellent results, Vineet[18]et al reported 90% results and Yokoyama[15] et al reported 89%. Our good to excellent results were 72.5 % (52.5+20%) which was lower than above results probably due to higher number of grade III cases,delay in primary fixation of fractures or due to the secondary closure procedures which lead to more comorbidity.

IV. Conclusion

In the current study, 47.5% fractures were open grade 1, 25% open grade 2 and 27.5% open grade 3. In our study, patients with open grade 1 fractures had 100% wound healing, 10.5% cases with screw breakage,15.7% of delayed union and **94.7%** good to excellent results; with open grade 2 fractures 10% patients had superficial wound infections, 40 % cases of delayed union and**70%** good to excellent results; and open grade 3 fractures had 36.3% cases of superficial infections, 54.5% cases of knee stiffness,36.4% cases of non-union and **36.3%** good to excellent results along with 36.3 % poor results. This explains the impacts of soft tissue injury on functional outcome and rate of complications.This study concludes that solid unreamed

interlocking nail can be used confidently in Grade I and II open fractures of tibial shaft and with caution in Grade III fractures.

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Figures

Figure **1 A**: Fracture at presentation; Figure **1 B**: After debridement; Figure **1 C**: After healing

Figure **2 A**: Simple short oblique fracture shaft of tibia and fibula; Figure **2 B**: Immediate post-operative; Figure **2 C**: Healing at 6 months

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