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Comparison of External Fixation and Non Reamed Intramedullary Nailing in Open Tibial Fractures

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SUMMARY

We report results of a randomized prospective clinical study comparing results of external skeletal fixation and closed unreamed intramedullary nail fixation in 50 patients of Gustilo grade-I and grade-II open tibial fractures. Patients were randomly assigned and were evaluated for time to union complications and eventual functional outcome using Alho et al criteria. AO tubular external fixator was used in 25 patients (group A) and unreamed tibial k-nail was used in other 25 patients with or without interlocking (group B). Initial management was similar in both groups with meticulous wound debridement and broad spectrum antibiotics. Patient age range was 20 - 60 years average being 37 years. Twenty seven patient were grade-I and 23 grade-II open fractures. Male: female 46:4 average healing time was 24 weeks with intramedullary nailing and 32 weeks with external fixator. Complications included delayed union in 10 cases of external fixator and 5 cases in intramedullary nailing. 12 pin tract and 5 wound infections in external fixation and 4 wound infections in intramedullary nailing. Patients with intramedullary nailing had slightly better results than external fixation with earlier union better range of motion at knee and ankle. Early mobility, fewer days of functional loss and better patient satisfaction as there was no need for meticulous pin care and it was cosmetically more acceptable. Main draw back of intramedullary nailing was longer operation time, radiation exposure to the surgeon. We conclude that closed intramedullary nailing is a better procedure for type-I and II open tibial shaft fracture.

INTRODUCTION

Tibial fracture is a common injury and because of subcutaneous location of bone fractures are not uncommonly compounded. Extent of soft time injury and amount of communition are directly related to severity of trauma. Treatment is often difficult and remains controversial. Accepted principles of treatment include debridement, broad spectrum antibiotics, stabilization of fractures and wound healing by secondary intention or delayed closure. Method of stabilization has remained controversial.

Gustilo, Mendoza and Williams[1] first related the importance of soft tissue damage as an important predictor of infection and eventual outcome, which has since been confirmed by Blick et al.[2], Fischer, Gustilo and Varecka[3].

Infection rate for these fractures is higher 0 to 2% grade-I and 2 to 7% grade-II.[4] Immediate use of broad spectrum antibiotics with aggressive debridement and early skeletal stabilization has greatly reduced infections and increased union[5,6].

External fixation has been used extensively for skeletal stabilization and to prevent further soft tissue damage and vascular insult. It facilitates wound care. Common problems are delayed union and pin tract infection. Use of small diameter intramedullary nails for closed nailing with or with interlocking and without opening fracture site has provided a new option for stabilization of these fractures[7].

In this study we have compared external fixation using uniplaner AO tubular fixator with closed unreamed intramedullary nailing using Kuntscher tibial nail with or without interlocking in open grade-I and grade-II tibial fractures. They were compared for rate of union, infections, malunion, joint mobility, eventual functional outcome and ease of care with these two methods. Remaining protocol was same.

PATIENTS AND METHODS

This study was carried out between October 1992 and December 1994 at Lahore General Hospital & Shaikh Zayed Hospital, Lahore. Fifty patients who presented at Accident and Emergency Department with open fractures of tibial shaft, Gustilo grade-I and grade-II and more than 5cm distal to tibial tubercle and 5cm proximal to distal tibial articular surface were included in this study. All patients included had sustained injury within 10 days. All patients below 14 years, infected wounds grade-III open fractures, poor wound conditions, and arterial injury were excluded.

Fifty patients included in the study were randomized patients with even number included in intramedullary nailing group (B) and odd numbers in fixator group (A). They were 27 patients with Gustilo grade-I open fractures and 23 patients with Gustilo grade-II open fractures.

Gustilo Classification

Originally described by Gustilo and Anderson[8] in 1976 divided open fracture into 3 types. Type-I, II and III revised in 1984[1].

- **Type-I**
  Low energy injuries with minimal soft tissue damage, wound less than 1cm in length and clean.

- **Type-II**
  Wound 1-10cm with slight or moderate comminution. No or slight periosteal stripping of bone fragments.

- **Type-III**
  Most severe pattern of open fractures, high injury trauma with severe comminution, larger wound or flap and or severe muscle damage. Any fracture occurring in farmyard environment. Any fracture which is segmental and displaced or high velocity gunshot.

- **Type-III A**
  As type-III but with good soft tissue cover inspite of soft tissue laceration or flaps, extensive osseous comminution or segmental fractures.

- **Type-III B**
  As type-III but with considerable exposed bone due to periosteal stripping.

- **Type-III C**
  As type-III but with a major vascular injury requiring repair for limb salvage.

All patients underwent meticulous wound debridement and irrigation after culture and sensitivity specimen were taken and broad-spectrum parenteral antibiotics were started which included a first generation cephalosporin and gentamycin for 5 days. Prophylaxis against tetanus was provided. All wounds were left open and allowed to heal with secondary intention.

Group-A odd numbers were managed with external fixation. Locally manufactured AO tubular external fixator was used with Schanz screws. Fixator was applied at the time of initial wound debridement with 3 screws in proximal and 3 in distal fragment. Fracture reduction was achieved with traction on fracture table. Out of 25 patients 15 were treated with uniplanner fixators, 9 with triangular biplane and 1 with mediolateral biplane fixator. Patients were allowed, weight bearing as tolerated with crutches as soon as they were comfortable. Fixator was dynamized at 6 weeks and full weight bearing was permitted. Fixator was removed upon radiological healing at fracture site and patellar tendon bearing cast was applied for 6 weeks. During the treatment patient was instructed on care of pin tracts, muscle strengthening, knee and ankle range of motion exercises.

For group-B (I/M nail group) after initial debridement and sterile dressing the limb was immobilized in a posterior splint, wound was managed with dressings. Parenteral antibiotics were given for 5 days. Closed intramedullary nailing was done on an average 10th day (range 7-12 days), if the wound was found healthy. Locally modified Kuntscher nail was used which was bent 15 degrees

8cm from proximal end and mediolateral 4mm screw holes were made proximally and distally for interlocking. 10 patients had dynamic interlocking in distal fragment. 15 patients were treated without interlocking, external stabilization to control the rotation was carried out with PTB cast on 10th day after stitch removal. Patients were ambulated, weight bearing as tolerated progressing to full weight bearing with a cane.

Median follow up period was 42 weeks (range 36-52 weeks). At follow up patients were examined clinically and radiographically. Union at follow up was determined by lack of pain or movements at fracture site, ability to bear full weight unprotected and presence of bridging callus on AP and lateral view with atleast partial obliteration of fracture line. Angular deformity was measured on X-rays, rotational deformity and shortening measured clinically. Results were graded as excellent good fair and poor using Alho et al.[9] criteria (Table 1). Malunion was defined as shortening greater than 2cm and angular deformity greater than 10 degrees rotation greater than 15 degrees.

Table 1: Follow up evaluation (Alho et al)[9].

Derangement	*Excellent*	*Good*	*Fair*	*Poor*
Varus or valgus	3°	5°	10°	>10°
Ante- or recurvatum	5°	10°	15°	>15°
Internal rotation	5°	10°	20°	>20°
External rotation	10°	15°	20°	>20°
Shortening	1 cm	2 cm	3 cm	>3 cm
Knee flextion	>120°	120°	90°	<90°
Knee extension deficit	5°	10°	15°	>15°
Ankle dorsiflextion	>20°	20°	10°	<10°
Ankle plantar flextion	>30°	30°	20°	<20°
Foot motion (fracture of normal)	5/6	2/3	1/3	<1/3
Pain or swelling	None	Minor	Significant	Severe

RESULTS

Out of 50 patients 46 (92%) were male and 4 (8%) were female. The average age was 29 years (range 20-60 years), with 70% in 3rd decade of life.

Forty eight were injured in road traffic accident, 2 were beaten by decoits.

Out of 50 fractures 26 (52%) were in middle third of shaft, 18 (36%) were in lower 1/3 and 6 were in upper 1/3 of tibial diaphysis (Table 2).

Table 2: Site of fractures (n=50)

	Number	*Percent*
Proximal 1/3rd	6	12
Middle 1/3rd	26	52
Distal 1/3rd	18	36
Total	50	100%

Out of 50, patients 38 (76%) were either spiral, oblique or transverse. 12 (24%) were comminuted with butterfly fragment (Table 3). 27 (54%) were Gustilo grade-I and 23 (46%) Gustilo grade-II.

Table 3: Classification of fracture (Johner and Wruhs)

Simple	
Spiral (A1)=	5
Oblique (A2)=	13
Transverse (A3)=	20
Butterfly	
Torsion (B1)=	4
One bending (B2)=	3
Two bending (B3)=	2
Comminuted	
Tortion (C1)=	3
Segmental (C2)=	0
Crush (C3)=	0
Total	50

Patient treated with external fixator were able to ambulate at an average of 6 weeks independently and those treated with intramedullary nail were at an average 4 weeks. Average duration of healing with external fixator was 32 weeks (range 24-52 weeks) and with intramedullary nailing was 24

weeks (range 20-52 weeks). On analyzing the gait at 24th weeks, limp was present in 5 cases (2 with nailing group and 3 with fixator group). Pain on walking was present in 1 patient with nailing and in 2 patients in fixator group.

Average deformities were measured as 7 degrees of varus and 8 degrees of valgus after both methods. Average posterior angulation was 4 degrees after fixator and 5 degrees with nailing. Average internal rotation deformity was 8 degrees with fixator and 6 degrees with nailing. Average shortening upto 2 cm was present in 3 patients with fixator and none with the nailing group. Lengthening upto 2cm was present in 2 cases with nailing and none with fixator.

Table 4: Results (n=25)

	Ext. Fixator	*I/M nail*
Follow up weeks	52	52
Time to full weight bearing (average)	6 weeks	4 weeks
Weeks to union (range)	32 (24.52)	24 (20.52)
Final motion		
Knee	80-99° (95°)	103-111° (108°)
Ankle	35°	43°
Excellent	6	12
Good	9	8
Fair	6	3
Poor	4	2

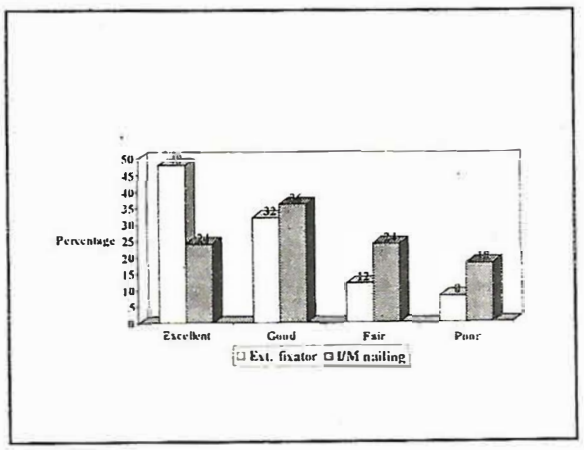

Fig. 1: End results (n=50) External fixator (n=25) I/M nailing (n=25).

Range of motion with external fixator at knee was 0-95 degrees (range 84 to 99 degrees) at ankle was 10 degrees dorsoflexionand 25 degrees planter fixation. With intramedullary nail at knee average range of motion 108 degrees (range 103 to 111 degrees) at an ankle was 15 degrees dorxiflexion and 28 degrees planter flexion (Table 4). Results graded according to Alho et al criteria. In nailing group 12 cases (48%) were excellent 8 cases (32%) were good, 6 cases (24%) were fair and 4 cases (16%) were poor. While in external fixation group 6 cases (24%) were excellent, 9 cases (36%) were good, 6 cases (24%) were fair and 2 cases (8%) were poor (Fig. 1).

Table 5: Complication (n=25).

	Ext. Fixator	*I/M nail*
Systemic	None	None
Dealyed union	10	6
Non-union	Non	None
Shortening (upto 2cm)	3	0
Lengthening (upto 2cm)	0	2
Pin track infection	1	-
Wound infection	6	4
Deep infection	5	4
Incarcinationof nail	-	1

Table 6: Infective organisms.

	Patzakis et al.[10] *(1975)*	*Gustile (1976)*[8]	*Present Study*
Staph. aureus	13.53%	37%	50%
Kleibsella	26.47%	13.99%	0
Pseudomonas	20%	11.9%	25%
Others	40%	27.2%	25%

Table 7: Analysis of deformity (All figures are average degrees).

	External fixator	*I/M nailing*
Varus	7°	7°
Valgus	8°	8°
Anterior ang.	8°	4°
Posterior ang.	4°	3°
External	10°	5°
Internal rotation	8°	6°
Short <2cm	3°	0
Length <2cm	0	2°

Table 8: Comparison with study at king county hospital centre new york (1994, JBJS).

	External Fixator	
	King County Hospital (n=14)	*Shaikh Zayed Hospital (n=25)*
1. Follow up (weeks)	22	42
2. Weeks to PWB	11.3 (6-20)	6
3. Weeks to union (range)	28.3 (14-38)	32
4. Final motion		
Knee	-120°	-95°
Ankle	-30°	35°
5. Infection		
Pin tract	3	12
Superficial	2	6
Deep (location)	1	0
6. Arterial injury	0	0
7. Malunion	2	2
8. Delayed union	2	10
9. Non-union	0	0

Complications

Delayed union was considered when no calus was present at 24 weeks with pain and non union at 32 weeks with inability to bear full weight and presence of pain on weight bearing. Delayed union was present in 10 patients (40%) with external fixation and 6 patients (24%) with nailing. Non union was noted in no patient in either of the group (Table 5).

In 1 patient treated with intramedullary nailing the nail got incarcerated in the lateral cortex of tibia due to failure of image intensifier and was corrected with mini open reduction. Wound infection was noted in 5 cases with external fixator (20%) and in 4 cases (16%) with intramedullary nailing which cleared up after debridement and use of appropriate antibiotics. The caustive organisms were Staph Aureus and Pseudomonas in majority of the cases (Table 6) compares results with international study. In external fixation 12 patients developed pin tract infection which were treated with daily dressing and appropriate antibiotics. Infection cleared in 8 patients but in 4 patients removal of the pins and debridement had to be carried out. None of the patients developed osteomyelitis.

Table 9: Comparison with study at king county hospital centre new york (1994, JBJS).

	Intramedullary Fixator	
	King County Hospital (n=14)	*Shaikh Zayed Hospital (n=25)*
1. Follow up (weeks)	20	42
2. Weeks to PWB	14.4 (4-22)	4
3. Weeks to union (range)	23 (12-30)	24 (12-32)
4. Final motion		
Knee	-130°	-108°
Ankle	-35°	43°
5. Infection		
Pin tract	0	0
Superficial	2	4
Deep (localized)	1	0
6. Arterial injury	1	0
7. Malunion	0	0
8. Delayed union	2	6
9. Non-union	0	0

DISCUSSION

Despite devices for rigid fixation, modern antibiotics and procedure for reconstruction of soft tissues there is still high incidence of complications in open tibial fractures.

Tibia has a poor soft tissue coverage and blood

supply and easily injured because of anatomical location. Open fractures are usually associated with significant level of energy and result in extensive soft tissue damage and periosteol stripping of bone. Goals of treatment in open tibial fractures is prevention of infection, healing of fracture and restoration of function of the extremity. Initial treatment often affects ultimate outcome. During the last 2 decades, use of standarized protocols have reduce complications and amputation rate[2,5]. Reconstruction of soft tissue envelop and stabilization of fracture are crucial factors in reducing complications.

Prevention of wound infection requires thorough debridement, appropriate antibiotics and stabilization of the fractures. Infection in open fractures has been reported to be 5-15%[5,10]. In our study 5 cases in 25 patients in external fixaton and 4 cases in close nailing (16%) developed superficial wound infection. The incidence is higher than international studies but appears to be due to delay in the initial treatment which was more than 12 hours in majority of the patients. Pin tract infections have been reported to be upto 44%[11] in various international studies. Pin tract infection in our study occurred in 12 patients out of 25 (48%) whichis due to poor quality of the Schanz screws, lack of education and poor compliance for pin care by the patient. Infection resolved either with antibiotics and local wound care or removal of the pins.

Adequate stabilization of fractures is an important factor in preventing infection and encouraging healing many methods have been used including casts, pin and plaster, flexible intramedullary nail, external fixators, plating. Over the last decade unreamed locked intramedullary nails have also been introduced. Ideal method of fixation is still controversal. Santaro et al 1990 reported a prospective randomized study which compared stabilization with external fixator and non ream locking nail. They found higher union rate with intramedullary nail and shorter time to union fewer malunions. Although theoratical argument based on blood supply to fractures favours external fixation but Rhinelander[10] found that I/M nailing interrupted blood supply temporarily and then only when there was direct contact with cortex. Unreamed nails have the advantage that they do not require a tight fit. In our study also union rate, time to union, range of motion were both better than external fixator. Cosmesis was better and patients were able to ambulate independently earlier. Disadvantages the operation takes a longer time needs flouroscopic control and there is radiation exposure to surgeon and patient and requires experties.

External fixator has advantages that it is very easy to apply less time for operation, wound care remains easy but disadvantages that it is bulky, cumbersome, has poor cosmesis high rate of pin tract infection requiring continued pin care.

Although differences in ultimate results were not very significant but intramedullary nailing had better acceptance by the patient, was easier to manage and did not require regular pin care. For comparison of a results international study from Kings County Hospital New York is shown in Table 7 and 8. Our results were comparable except for infection.

CONCLUSION

We conclude that intramedullary nailing is the preferred method of treatment for grade-I and II open fracture of tibia in patients which present early for treatment and where the facility is available.

REFERENCES

1. Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type-III (severe) open fractures. A new classificationo f type-III open fractures. Trauma 1984; 24: 742-46.
2. Blick SS, Brumback RJ, Lakatos R, Poka A, Burges AR. Early prophylactic bone grafting of high energy tibial fractures. Clinical Orthop 240: 21-41; 1989.
3. Fischer MD, Gustilo RB, Varecka TF. Timing of flap coverage bone grafting and intramedullary nailing in patients who have a fracture of tibial shaft with extensive soft tissue injury. J Bone & Joint Surg 73-A; 1316-22; 1991.
4. Gustilo RB, Merkow RIL, Templeman D. The management of open fracture. J Bone & Joint Surg 72-A; 299-304; 1990.
5. Edwards CC, Simon SC, Browner BD, Weigel MC. Severe open tibial fractures. Results treating 202 injuries with external fixation. Clinical Orthop 230: 98-115; 1988.
6. Patzakis MJ, Wilkins JP, Moore TM. Consideration reducing the infection rate in open tibial fractures. Clin Orthop 1983; 178: 36-41.
7. Steven A, Olson MD. Open fractures of the tibial shaft.

Current treatment, J Bone Joint Surg Vol. 78-A No.9 1996: 1428-37.

8. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty five open fractures of long bones. Retrospective and prospective analysis. J Bone Joint Surg 58-A: 453-58; 1976.
9. Amti Alho MD, Bentrud JG, Hogevold HE, Ekland A, stromsde K. Comparison functionalbracing locked intermedullary nailing in treatment of displaced tibial shaft fractures. Clinical Orthopaedic and Related Research 277; 1992: 243-50.
10. Patzakis MJ, Dorr LD, Ivler D, Moore TM, Harvey JP Jr. The early management of open joint injuries. A prospective study of one hundred and forty patients. J Bone Joint Surg 1975; 57-A: 8.
11. McGraw J, Lim EVA. Treatment of open tibial shaft fractures. External fixation and secondary intramedullay nailing. J Bone Joint Surg 1988; 70-A: 900-911.
12. Rhinelander FW. Tibial blood supply in relation to fracture healing. Clinical Orthopaedic 105; 34-81: 1974.

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