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ORIGINAL ARTICLE

ROLE OF EXTERNAL FIXATOR IN COMPOUND GRADE II &III A TIBIAL FRACTURE

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ABSTRACT: In a field of trauma surgery, compound fracture of tibia had always been encountered with high complication rates. Bone and soft tissue injuries need aggressive yet meticulous management to avoid further damage that results in poor healing. The optimum treatment for open fractures of tibia remains controversial. Our study is to evaluate the role of external fixator application in the treatment of compound Grade II & IIIA tibial fractures. All 25 patients who presented with compound Grade-II & Grade-III A tibial fractures were considered for the study. The results obtained were analysed, In regards to the advantage and disadvantage in terms of soft tissue healing, time of fracture union and ultimate functional outcome. We had only 4.5% nonunion, malunion occurred in 2 patients, and bone grafting was needed in only 3 patients out of the 22 patients in our study. The initial external fixation afforded excellent accessibility for management of the soft-tissue injuries. The prospective collection of data from our series mainly comprising open tibial fractures has shown that techniques using external fixators are quick and easy to apply, especially in a polytraumatized patient, and that they minimize the risk of severe soft tissue complications; a significant decrease in the rate of complications. However, the time frames for union derived from the treatment of closed fractures are not applicable.

KEYWORDS: External fixator, Tibia fracture compound fracture.

INTRODUCTION: It is a well-known fact that worldwide, high-energy trauma is the major cause of mortality and morbidity in the younger age group. In a field of trauma surgery, open fractures of the leg remains the injuries with high complication rate. Bone and soft tissue injuries need aggressive yet careful treatment to avoid further damage that results in uncomplicated healing.

Due to its location, structural anatomy and sparse anterior soft tissue coverage, the tibia is particularly prone to exposure and ischemia due to injury. The optimum treatment for open fractures of tibia remains controversial. Treatment options include wound debridement, reduction and immobilization with cast, external fixation and primary internal fixation.

Often soft tissue injuries can be assessed only superficially in the emergency room. Knowledge of the history of injury and its location is often helpful when determining the extent of soft tissue contusions, crushed areas of skin and burns reflect a large amount of energy transferred to the limb. Gross contamination with soil, grass or other foreign material should be noted. The dimensions and location of all open wounds should be recorded.

It has been experimentally and clinically proved that immobilization of the fracture is the most important factor in facilitating the biological process of vascularization of soft tissues and bone, the healing of the wound and healing of the fractures.

The importance of external fixator in the treatment of compound fractures is in the stabilization of fractures. Surgical stabilization of the fractures through osteosynthesis is not considered appropriate because of the risk of infection and increased necrosis of the soft tissues. For

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this reason, external fixation is the most frequent step in the treatment of these kinds of fractures. It is quick and easy to apply, especially in a polytraumatized patient.

AIMS AND OBJECTIVES: This study is undertaken to evaluate the role of external fixator application in the treatment of compound tibial fractures.

The results so obtained shall be analyzed as to the advantage and disadvantage in terms of soft tissue healing, time of fracture union and ultimate functional outcome.

MATERIALS AND METHODS: All 25 patients who presented to Rajah Muthiah Medical College & Hospital with compound Grade-II & Grade-III tibial fractures between September 2005 and September 2007 were considered for the study. Fractures were graded according to the Gustilo et al 1987 classification.

INCLUSION CRITERIA: Patients in whom the fracture configuration is amenable to fixation and is having an intact medullary cavity of sufficient length so that external fixators can be applied.

EXCLUSION CRITERIA: For the study group, we excluded fractures associated with a known arterial injury and those with an intra-articular extension and three patients were not included in the study because of inadequate follow-up.

AGE & SEX RATIO: After these exclusions, Twenty two patients were followed to the completion of healing and were studied with the use of pre-operative and post-operative radiographs and hospital and office charts. The ages of the patients ranged from twenty one years to seventy four years. Seventeen patients were males and five were females. Three patients were lost to follow – up.

MODE OF INJURY: The fractures were due to a motor-vehicle accident (fifteen patients), motor-vehicle pedestrian accident (five patients), and fall from height (two patients).

PRE-OPERATIVE PROTOCOL: We followed a standard treatment protocol. Prophylaxis for tetanus was routinely administered, Irrigation and antibiotics began in the emergency room and operation was performed with continued irrigation, debridement and stabilization as soon as the patient's general condition was satisfactory. Antibiotics were continued for 72 hours after the initial procedure and for 48 hours after each additional procedure.

Debridement was repeated at 48-hour intervals until the wound was clean and all necrotic tissue had been removed. Bone fragments with no soft-tissue attachments were usually discarded. All patients were admitted to the ward. Compartment pressures were measured during the initial debridement at the discretion of the attending surgeon, depending on the clinical findings, the pattern of the fracture, and the extent of the soft-tissue injury.

SOFT TISSUE PROCEDURES: Soft-tissue cover was given in each case which required it, by either a muscle flap or skin graft or both from 1 to 15 days after the injury. The 22 patients required 14 rotation flaps and 18 split-thickness skin grafts. After muscle-flap procedures, cephalosporin treatment was continued. In only four patients was it necessary to allow some portion of the wound to heal by secondary intention.

A patient was considered to have an infection of the wound when clinical signs and symptoms of infection were present and either a culture or gram stain was positive. Superficial

infection involved the skin and subcutaneous tissues. Deep infection was below the deep fascia and involved the site of the fracture.

SECONDARY PROCEDURES: Prophylactic bone grafting was done at 8 to 14 weeks (mean 11) was performed for patients with severely comminuted and segmental fractures. It was not used when there was over 75% of bony apposition or definite callus formation by 8 to 10 weeks.

Three patients were treated exclusively in the external fixator and ten patients were converted to the intramedullary nail at 3 to 15 weeks (mean 6 weeks), six patients were put on PTB cast at 6 to 21 weeks (mean 12.5 weeks) this was performed on completion of soft tissue healing if a stable fracture pattern was present, one patient was put on ILLIZAROV fixator at 21 weeks and one patient was put on BK cast at 18 weeks.

WEIGHT BEARING: Range of motion exercises with a physiotherapist were started before three weeks, but patients remained non-weight-bearing, until toe-touching was allowed at three weeks and continued until callus appeared at the fracture site. Partial weight-bearing then started provided that the fracture site was painless on examination or weight bearing. Full weight-bearing was allowed when bridging callus was visible on radiographs.

UNION OF FRACTURES: All fractures were immobilized until there was evidence of union according to both radiographic and clinical criteria. The radiographic criteria included the presence of external callus or cortical bone spanning the site of the fracture. Union was determined clinically by the absence of both tenderness and motion at the site of the fracture.

Delayed union was defined as absence of union six months after the injury. The duration of external fixation varied according to the over-all treatment plan, the average time being 16.5 weeks (range, 3 to 42 weeks). After the fixators were removed the pin tract was curetted. The average time from injury to intramedullary fixation was 6 weeks (range, 3 to 15 weeks).

REHABILITATION: Early functional rehabilitation should be a key part of the treatment of open fractures of the tibial shaft. Physical therapy programs to emphasize the range of motion of the knee and ankle are critical in the first few weeks after the injury. The patient should be encouraged to maintain good muscle tone, even if no weight-bearing or only toe-touch weight-bearing is allowed. Patients who have a fracture with bone loss were not being allowed to bear weight on the affected extremity until there are radiographic signs of union.

RESULTS & ANALYSIS: Twenty two patients who presented to Rajah Muthiah Medical College & Hospital with Grade II & Grade III open tibial fractures according to Gustilo et al's classification between September 2005 to September 2007 were considered for this prospective study.

SEX INCIDENCE: There were seventeen male patients & five female patients in this study.

AGE RATIO: This study has patients of different age groups, with the youngest patient aged 21yrs & the oldest patient aged 74yrs.Maximum number of patients (six) being in the age group of 40-50yrs.

SIDE OF INJURY: The fractures occurred on the right leg in 15 patients & in the left leg in the remaining 7 patients.

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Age Groups (Years)	No of Patients
20-30	4
30-40	4
40-50	6
50-60	4
60-70	3
> 70	1
AGE INCIDENCE	

Motor Vehicle accident	15 Patients
Motor Vehicle Vs pedestrian	5 Patients
Fall from height	2 Patients
MODE OF INJURY	

Type of Fracture*	No of Patients
Grade II	3
Grade III A	12
Grade III B	7
TYPE OF FRACTURE	

* Gustilo et al Classification

MODE OF INJURY: The commonest mode of injury was found to be motor vehicle accident found in about fifteen patients, five patients sustained motor vehicle v/s pedestrian accident & and two patients sustained injury due to fall from height.

TYPE OF FRACTURE: The fractures were classified according to Gustilo et al classification, in which Grade IIIA with 12 patients was the commonest, Grade IIIB was found in 7 patients and 3 patients were of Grade II. Middle 1/3rd fractures were the commonest site presenting in 12 patients.

ASSOCIATED INJURIES: Ten patients had associated injuries with seven patients sustaining other fractures, two patients had head injury and one patient sustained blunt injury of the abdomen.

TIME OF PRESENTATION SINCE INJURY: 73 % of patients had presented within 6 hrs of injury and the rest 27 % presented after 6 hrs of injury, the earliest patient to report was within 30mins and the longest time to present since injury was 32hrs.

SOFT TISSUE PROCEDURES: 64 % patients required soft tissue repair with SSG & flap cover, while 18 % patients needed only SSG, the remaining 18 % patients did not require any soft tissue repair. About 61 % of the soft tissue procedures were done within 72 hrs.

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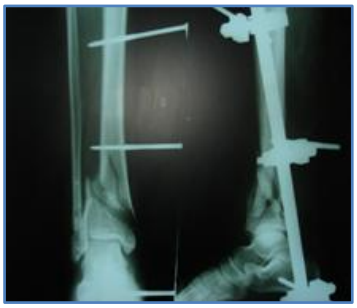
UNION OF THE FRACTURE: Healing was defined as bridging callus on antero-posterior and lateral radiographs, with no pain on palpation or weight-bearing. In cases that had bone grafting, a complete synostosis was considered as evidence of healing.

The average time to union of the fracture was 5.8months (range, 3 to 12.5 months). Three patients had delayed union and one patient had non-union. Although three patients had iliac-bone grafting for a segmental bone defect, no patient needed bone-grafting for delayed union or nonunion. For those patients converted to the intramedullary nail group, the average time of fracture healing was 4.7months (3 to 9) and 28.3 weeks (14 to 38) for the external fixation group.

Case 1



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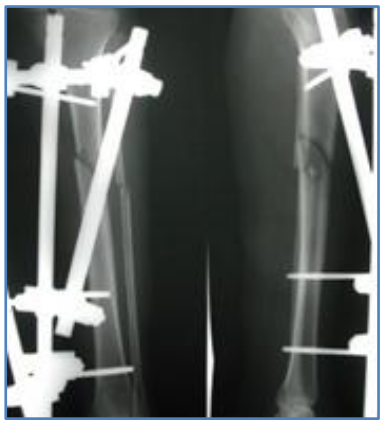
Case 2






INFECTION: Six patients developed pin tract infection of the external fixator. All the infections healed rapidly on treatment with dressings and antibiotics, and no infection developed after the nailing in any patient. There were no deep infections. There were no late amputations.

ALIGNMENT: Varus or valgus angulations of 5 degrees or less, anterior or posterior angulations of 10 degrees or less, and shortening of less than two centimeter as compared with the contra-lateral leg, were the criteria for satisfactory alignment on radiographic assessment. At the most recent follow-up, nineteen patients had satisfactory alignment. Two patients, both of whom had Grade-IIIb fracture, had a malunion.

Associated Injuries	No. of Patients
Other Fractures	7
Head injury	2
Abdominal injury	1
ASSOCIATED INJURIES	

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Procedures	No of Patients
SSG*	4
SSG with Flap Cover	14
None	4
SOFT TISSUE PROCEDURES	

* Split thickness skin Graft

Duration in weeks	No. of patients
3 - 6	7
6 - 12	3
12 - 20	6
> 20	6
DURATION IN FIXATOR	

Time in months	No. of Patients
3 -4	4
4 - 5	7
5 - 6	1
6 - 7	4
> 7	5
Non - Union	1
TIME FOR UNION	

LIMB-LENGTH DISCREPANCY: One patient (70yr old male) had a limb-length discrepancy of 1.5 centimeter shortening as compared to the other limb which was due to segmental bone loss. There was concurrent pelvic injury in this patient.

ADDITIONAL OPERATIONS: Additional operative procedures included bone-grafting in two patients, and interlocking nailing done in ten patients.

OTHER COMPLICATIONS: Other complications included that of equinus contracture in one case, which also had pelvic fracture and was on external fixator for 25 weeks, flap failure occurred in one case.

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Procedures	No. of Patients
ILN	10
PTB	4
BK CAST	1
ILLIZAROV	1
PTB AND BG	2
BG	1
ADDITIONAL PROCEDURES	

Table I: Details of the patients, the mechanism of injury and associated injuries in the open tibial fractures:

External fixator	(n=22)
Male: female	17:5
Mean age (years; range)	45 (21 to 70)
A) Mechanism	
Motor-vehicle accident	15
Motor-vehicle v pedestrian	5
Fall from height	2
Type of fracture	
Grade II	3
Grade IIIA	12
Grade IIIB	7
Associated injury	
Other fracture	7
Head injury	2
Abdominal injury	1

Table II. Secondary procedures

External fixator	(n=22)
Muscle flaps	
Days to flap (range)	6.9 days (3 to 15)
Skin graft	18
Bone graft	3

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WEIGHT BEARING & MOTION AT KNEE & ANKLE:
Results in External fixator group:

Follow-up:

Partial weight-bearing (range)	_	Mean 7.3 weeks (6 to 9.4 weeks)
Time to union (range in months)	–	Mean 5.8 months (3 to 12.5 month)

Motion at union

Knee (degrees)	–	Mean 126.4 (123 to 129.2)

WEIGHT-BEARING: Decisions about weight-bearing and frame removal were made individually for each patient. Partial weight-bearing with the fixator in place was started after a median period of 52 days. One patient remained non-weight-bearing in order to protect the associated pelvic injuries on the same side. Six patients had a PTB cast applied before they were allowed to take full weight bearing.

DISCUSSION: The management of patients who have an open tibial fracture often presents a major challenge, and for this reason it has received much attention in the literature. Most authors who criticize external fixation cite high complication rates (as high as 62%, Weber, 1986) but refer to studies conducted prior to the above modifications.

To continue to cite such studies obscures the fact that current external fixation technique usually has a very low complication rate. Schuind (1989) found only 9 complications in 225 cases; Weiland (1998) stated that there are "few major complications" with current techniques of external fixation.

Associated injuries of the ipsilateral extremity may adversely affect healing of the fracture and ultimate function of the extremity. The prevention of infection after an open fracture of the tibia begins with thorough debridement of all necrotic and traumatized tissue and copious irrigation.

Antibiotics have been demonstrated to decrease the incidence of infection in patients who have an open fracture of the tibia that has been treated with irrigation, debridement, antibiotics, and immobilization in a cast or external fixation. In our study, an infection developed in just 4.5 per cent of our patients. All infections resolved after debridement and intravenous administration of antibiotics.

SOFT TISSUE COVERAGE: An important factor is the timing of soft-tissue coverage. Fischer et al (1991) reported that only two of 11 patients became infected after early cover (2 weeks) as against nine of 13 patients who had sub-acute or late cover. In our study all the patients were given soft tissue coverage within a period of 15 days. Only one of the twenty two patients went for a flap failure, all other patients healed well without infection. Early cover not only reduces infection, but also improves the blood supply to the healing bone.

Adequate stabilization is also important in preventing infection and encouraging healing.

Blick et al demonstrated superb results with a high rate of union (96%) a low rate of malunion and chronic osteomyelitis in only one patient (2%). These fractures were all treated with

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external fixation with an intensive protocol. Karlstrom and Olerud(1975), Behrens et al (1983b) and Etter et al (1983) have shown that open tibial fractures stabilized by external fixators have a better union rate when bone grafting is used. Heiser and Jacobs (1983) reported 50% nonunion.

Our study produced only 4.5% nonunion, malunion occurred in 2 patients, and bone grafting was needed in only 3 patients out of the 22 patientsin our study.

In 1972, Olerud and Karlstrom were the first to advocate secondary intramedullary nailing of the tibia. They reported excellent results in fifteen patients who were treated by nailing. In 1975, they were the first to mention nailing after external fixation, in a patient in whom an intramedullary infection developed after a Type- II or III open fracture had been nailed because of delayed union after primary treatment by external fixation.

In 1986, Puno et al, while not reporting on any specific patients, stated that no fracture that was nailed secondarily after removal of a fixator became infected. They recommended a five to seven days delay after removal of the fixator before nailing.

Our study of 22 patients had an additional procedure of intramedullary nailing done in 10 patients and we did not have any deep infection in the patients converted to intramedullary nailing following external fixators.

Garg J Claney et al during the period from 1970- 1976 have reported 14 % superficial infections and 42% delayed union in fractures of tibia following external fixation.

In our study, twenty seven per cent of the patients who were treated with external fixation had a pin-tract infection, all of which were treated successfully. The other major complication in our series was delayed healing of the fracture.

The initial external fixation afforded excellent accessibility for management of the soft-tissue injuries. Also, the rigidity of the fixation system allowed early mobilization and rehabilitation of the patients.

The most common "complication" currently in external fixators is pin tract infection. They are mainly Minor pin tract infection, those that merely require more patient education or better compliance, or oral antibiotics, should be recognized for that they are: minor. As Margaret McQueen has stated, these are not "complications", they are "expected problems".

The primary advantages of external fixation are in care of the wound, maintenance of the length and alignment of the tibia, and transportation of the patient. The theoretical disadvantages were found to be minimal which includes, infection, limb-length discrepancy, and delayed union.

CONCLUSION: Open fractures of the tibial shaft represent a limb-threatening, and potentially life threatening, emergency. Optimum treatment involves appropriate initial evaluation and administration of antibiotics; urgent operative debridement and skeletal stabilization; repeated soft-tissue debridement; and early soft-tissue closure or flap coverage, or both.

Adequate stabilization is also important in preventing infection and encouraging healing. External fixation of open fractures or fractures with severe soft-tissue damage does not require additional disruption of either the soft-tissue envelope or the vascularity of the osseous structures.

The implantation of fixation devices within an open fracture, a matter of some concern, is also avoided. Studies have indicated that, in the treatment of severely contaminated fractures, external fixation is superior to intramedullary fixation in terms of decreased rates of infection and improved healing.

In the treatment of compound tibial fractures, the paramount goal should be to obtain a clean wound as well as a stable fracture with the use of whichever mechanical device is preferred by the surgeon. The biology of these injuries is certainly the most crucial factor and should be of primary concern, there is no substitute for a thorough understanding of the so-called personality of the fracture to help to determine the best choice of treatment.

It was the purpose of this study to examine the role of external fixator in the management of compound tibial fractures along with the safety and its effectiveness which depends upon three principles; the avoidance of damage to vital anatomical structures; the provision of access to the injury for primary and secondary procedures; and the need to meet the mechanical demands made by the patient and his injury.

The prospective collection of data from our series mainly comprising open tibial fractures has shown that techniques using external fixators are quick and easy to apply, especially in a polytraumatized patient, and that they minimize the risk of severe soft tissue complications; a significant decrease in the rate of complications. Surgery can be performed earlier. It avoids extensive soft-tissue dissection, uses limited access approaches and allows the surgeon to operate early without compromising the soft tissues. However, the time frames for union derived from the treatment of closed fractures are not applicable.

The good results and the low rate of complications reported in this series show that the proposed basic principles of external fixation have been adapted to. It is only a small series of 22 cases and hence a larger series would only show the efficacy of the method.

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