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MANAGEMENT OF COMPOUND FRACTURES OF TIBIA BY EXTERNAL FIXATION: A PROSPECTIVE STUDY FROM A RURAL HOSPITAL OF SOUTH INDIA

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ABSTRACT

***Background**: Introduction of external fixator is a revolution in the management of compound fractures tibia for it has saved many limbs from amputation. **Objectives**: to study the usage of external fixator in the treatment of compound tibial fracture and to assess the functional outcome of patient. **Methods**: During October 2005 to September 2007, 20 cases of open fracture tibia were selected based on Gustilo Anderson's classification with exclusion of Type 1 and type 3C wounds. Fractures were managed by using bilateral frame with transfixing pins and biplanar fixators. Patients were followed at 4 weeks interval with clinical and radiological assessment. The results were classified as good, moderate and poor depending upon the degree of deformity, degree of shortening, range of motion at neighbouring joint. **Results**: All patients were male belonging to age group 20 - 40 years with road traffic accidents. Eighty percent of the fractures were of Type III with middle 1/3 of leg common site. Good outcome was noted in 14 cases (70%) while 15% each of moderate and poor outcome. **Conclusions**: External fixators could be the choice of fixation in open fracture tibia and was found to be simple, economical and effective.*

KEY WORDS

Open tibial fracture, external fixation, rural hospital

INTRODUCTION

The management of compound fractures of tibia is a challenge to orthopedic surgeon. Number of methods have described and tested with varying results on the management of compound fractures[1-3].Introduction of external fixator is a revolution in the management of compound fractures tibia, for it has saved many limbs from amputation[4-7].

OBJECTIVES

1. To study the usage of external fixator in the treatment of compound tibial fracture,
2. To assess the functional outcome of patient with reference to rate of fracture union and range of movement at ankle joint and knee joint and to study the restoration of function of the limb.

METHODOLOGY

The study was conducted in Basaveshwar Teaching & General Hospital attached to Mahadevappa Rampure Medical College, Gulbarga. During October 2005 to September 2007, 20 cases of open fracture tibia were selected based on Gustilo Anderson's classification [8](table 1) as Type 1, 2, 3A, 3B and # based on the size of wound, degree of soft tissue injury, level of contamination, degree of bony injury and presence of neurovascular injury. Type

1 and type 3C wounds were excluded as type I were treated with primary intra-medullary interlocking nailing and type 3C were referred to vascular surgeon due to associated vascular injury. Patients belonging to age groups 20 to 40 years were included. Patients were initially examined in casualty regarding head injury, respiratory, cardiovascular and abdomen status. Intravenous fluids, antibiotics and intramuscular tetanus toxin and tetanus immunoglobulin were given. After haemo-dynamically stabilized were shifted to major OT for wound debridement and external fixator application within 24 hours.

OPERATIVE TECHNIQUES (Fig 1 & 2)

The basic frame components are the adjustable clamps used for articulation of the schanz pin to the steel tube. The clamps allow screw insertion in any desired plane, Hollow tubes with outside diameter of 11mm and length from 100-600mm, Schanz pins of diameter 4.5mm and Steinmann pins are used. The triple trocar is a universal instrument for guiding insertion of the schanz pin with conus. It consists of 5mm and 3.5mm drill sleeve with a 3.5mm trocar. The pin is first predrilled with a 3.5mm drill bit, then over drilled in the near cortex with a long 4.5mm drill bit. The universal chuck with a T-handle holds the schanz pins during insertion, while the wrenches are used to tighten the clamp nuts. Other instruments include the open compressor and distractor[9-10].

The fixator components are generally assembled into one of two basic frame types of configurations namely unilateral uniplanar, unilateral biplanar.

The one plane configurations are less obstructive and generally suffice for most injury situations. Two plane frames are more effective in neutralizing multi directional bending and torsional movements. However, they are only needed when dealing with severe comminuted fractures or with bone loss. The safe corridor for schanz pin insertion in the tibia is at level proximal to the tibial tubercle, schanz pins can be safely inserted within the arc of 220 degree. At level B, just below the tibial tubercle, the safe arc decreases to 140^0. At level C, in the distal third of the leg, the safe arc remains 140^0 but anterior tibial vessels and deep peroneal nerve become vulnerable as they cross the lateral tibial cortex. At level D, above the ankle joint, the safe arc is 120 degree. At levels E and F, steinmann pins in the tarsal or metatarsal bones may be used to splint the ankle joint if neurological or soft tissue injuries prevent the application of an external support. External fixators are usually applied under general or regional anaesthesia with the limb draped free so as to leave all pertinent skeletal land marks visible[11]. The insertion of schanz pin should be done in the following manner.

a. Assemble the triple trocar and penetrate soft tissue (through a stab incision) down to the bone surface.
b. Remove the trocar and drill through both cortices using a long 3.5mm drill bit.
c. Remove the drill sleeve, through the remaining 6 or 5mm sleeve over drill the near cortex using a long 4.5mm drill bit. The use of oscillating attachment combined with the three fluted drill bit is recommended.
d. Insert the depth gauge probe through the drill sleeve hooking the far cortex.
e. Loosen the locking pin, advance the knurled disk to the top of the drill sleeve and tighten the locking pin.
f. Remove the probe, place the threaded tip of the schanz pin in to the schanz pin recess of the knurled disk
g. Advance the universal chuck over the non-threaded end of the schanz pin until the tip of the probe touches the end of the universal

chuck. Tighten the universal chuck on to the schanz pin in this position.

h. Insert the schanz pin until the universal chuck nearly touches the top of the drill sleeve, the schanz pin is now fully inserted into far cortex.
i. Remove the drill sleeve and attach the adjustable clamp.

Unilateral uniplanar frame: This is applied as follows

Step I: Application of schanz pin close to the distal joint. The tube with the planned number of adjustable clamps is fixed to the schanz pin.

Step II: Application of second schanz pin across the most proximal adjustable clamp. At this time, three dimensional reduction of fracture is easy, observing axis and rotation of the foot by comparing it with uninjured leg.

Step III: The inner schanz pin is inserted about 2cm from the fracture area. The tubular fixator allows individualization of schanz pin placement according to fracture configuration. Prevention of drop foot by connecting metatarsal I and II to tube by means of schanz pin.

Unilateral Biplanar Frame: This consists of 2 interconnects simple unilateral frames to allow optimal wound access. The plane for the second frame should lie at an angle of 60-100 degree with the plane of the first frame. First the ventral fixator is applied in a nearly sagittal plane aiming towards the medial posterior tibial cortex. Next the medial fixator is applied at an angle between 60-100 degree and fixed with either 2 or 4 schanz pins. The tubes are interconnected by smooth pins.

Maneuvers for reduction of Fracture: In simple transverse fractures, stabilization at the fracture site is achieved by compressing main fragments against each other, taking care to avoid the tendency to angulate the fragments. The fixators are then used as a neutralization frame. In diaphyseal fractures, however this maneuver should only be considered in treating simple two fragment fracture with relatively long contact areas. In comminuted fracture neutralization frame is applied.

To diminish motion at fracture site and increase the stiffness of frame, the following was considered:

a. Principal frame should be applied in saggital plane.
b. Preloading of schanz pins
c. Increasing the number of pin in each bony fragment
d. Increasing the pins spread with in each fragment
e. Reducing the distance between bone and the longitudinal tube.

Frame application: It depends on site of wound that is opposite to the site of wound. If a soft tissue coverage procedure is required lateral on, then the side of frame application should be such, as to leave enough free area for the plastic surgery. The fixator was placed in neutralization mode in case of comminuted and butterfly fragment fractures, compression mode incase of transverse, oblique and segmental fractures so as to narrow fracture gap and improve stability. Relaxing skin incisions were placed around the pin tracts to avoid skin compression, bones were covered with overlying muscles, skin approximated with stay sutures. The foot and ankle were manipulated at the end of procedure to ensure absence of musculotendinous tethering by transverse pins. All these patients were followed at 4 weeks interval. Clinical and radiological assessment of the patients at follow up comprised of wound healing, tenderness at fracture site, degree of weight bearing, presence of callus, gap at fracture site, sclerosis at fracture ends and obliteration of medullary canal. Once the wound is clean and covered with healthy granulation tissue, plastic surgeon opinion sought

and treated accordingly. Static Quadriceps exercise was started immediate post-operatively. Knee and ankle motion was allowed 4 week from the operative day. Partial weight bearing was allowed in non-comminuted fractures 4-6 weeks later. In case of comminuted fractures 10-12 weeks from the day of surgery. Full weight bearing was allowed when there was radiological evidence of union. The results were classified as good, moderate or poor depending upon the degree of deformity, degree of shortening, range of motion at neighbouring joint. The degree of deformity and limb length discrepancy was assessed using the modified Anderson and Huntchins Criteria (table 2). The ankle and knee movements were graded as Full range-Normal; Significant loss of movement -In the knee - loss of extension up to $\geq 10^0$, and flexion up to 40^0, ankle - 25^0, but $< 50^0$ of flexion / extension; Insignificant loss - Anything less than but above the normal. Severe loss - both in knee and ankle, with loss of $> 50^0$ of flexion and extension. The results were classified as good, moderate and poor (**Table 2**).

Table 1: Gustilo – Anderson's classification of type of fracture

Types	No. of Patients
Type-I	0
Type -II	4
Type – III A	8
Type III B	8
Type – III C	0

Table 2: Modified Anderson &Huntchins Criteria to assess degree of deformity&limb length discrepancy.

Results	Shortening	Grade of deformity in Angulation (Malunion)
Good	<1 cm	Up to 5^0Varus / Valgus up to 10^0 Anterior / Posterior
Moderate	1-2cm	5-10^0 Varus / Valgus 10-20^0 Anterior / Posterior
Poor	> 2cm	> 10^0 Varus / Valgus > 20^0 anterior / Posterior

Table 3: Management of Associated Injuries

Associated Injury	Gustilo's Type	Side/Type	Management
Closed fracture both bone Right Forearm	Type –II	Right	Closed reduction and internal fixation with square nail
Closed Fracture right Femur M/3rd	Type III-B	Right	Intra-medullary interlocking nail for the fracture femur
Crush injury Right foot with fracture 1st and 2nd metatarsal bone	Type III A	Right	Wound debridement and fixed with k-wire

Fig 1: Wound debridement

Fig 2: Open wound

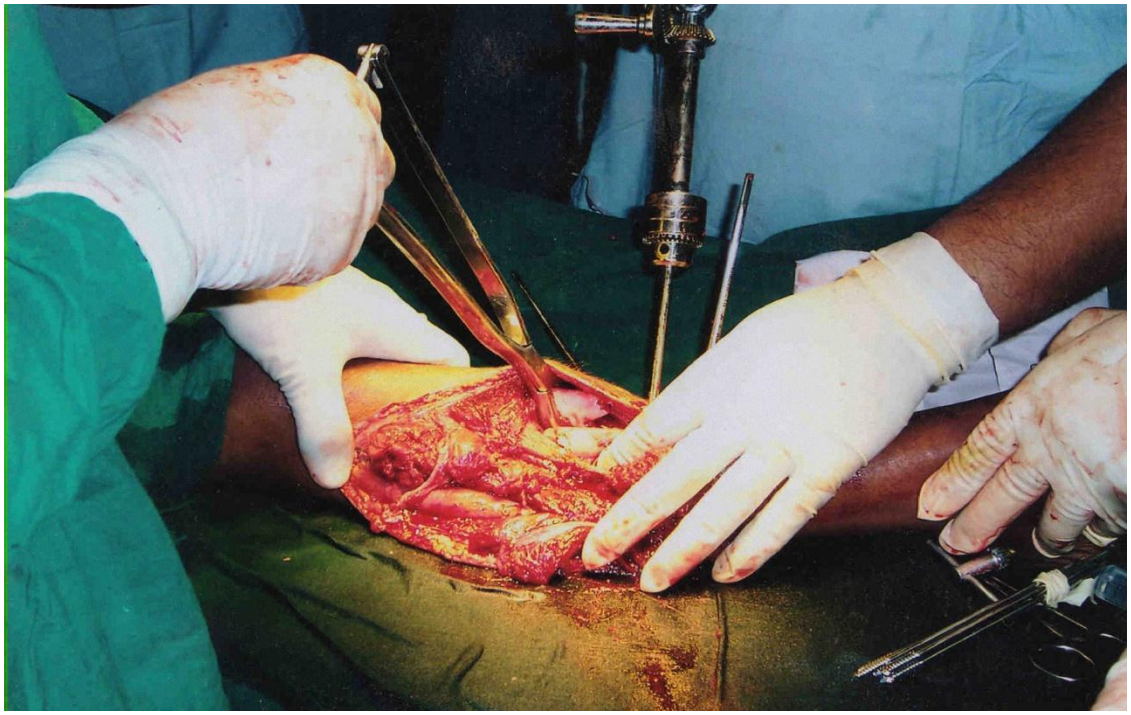

Fig 3: Operative procedure in progress

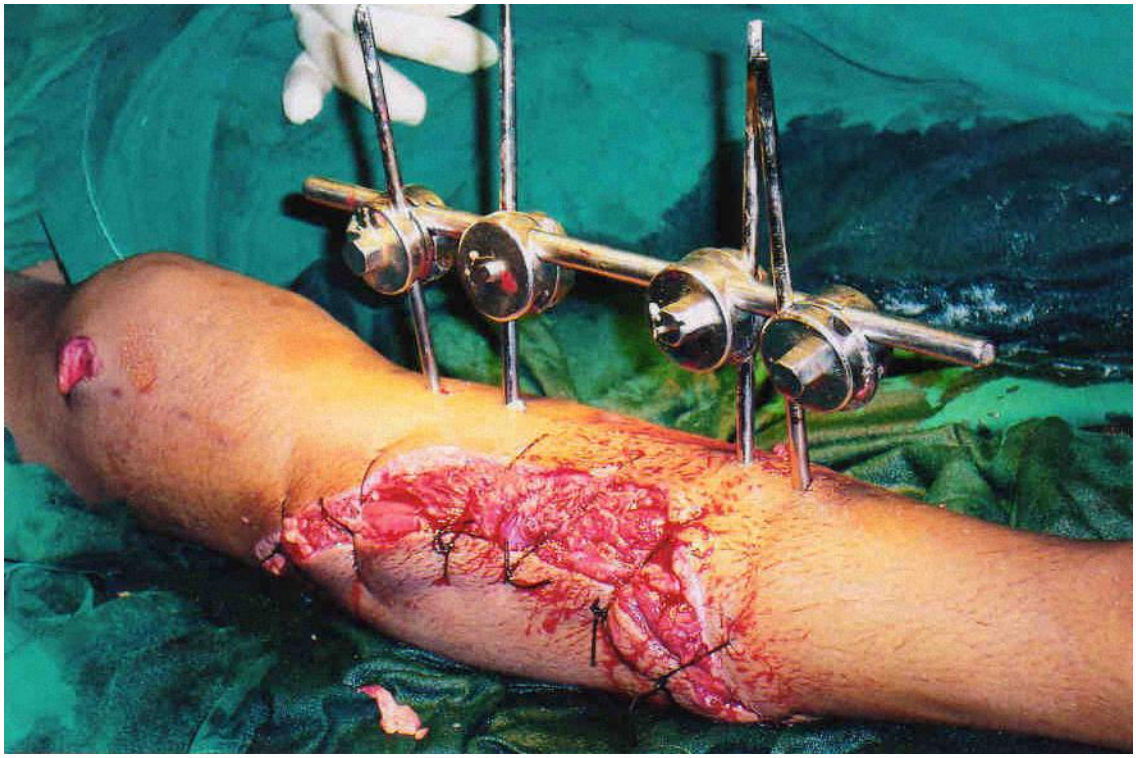

Fig 4: Operative procedure completed with fixators

Fig 5a: Results showing good outcome

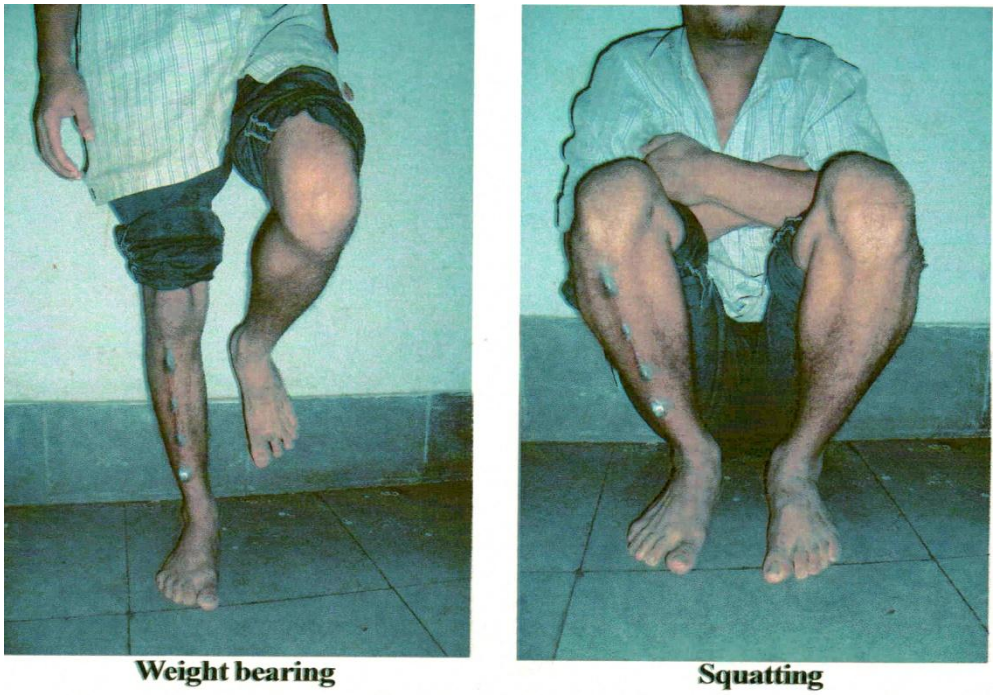

Fig 5b: Results showing good outcome

OBSERVATIONS

All patients were male belonging to age group 20 - 40 years with road traffic accidents. Eighty percent of the fractures were of Type III with middle 1/3 of leg common site. Good outcome was noted in 14 cases (70%) while 15% each of moderate and poor outcome (**Fig 3a & 3b**). Eight patients needed split skin grafting. One patient

had contra lateral closed fracture of both bone for which close reduction and internal fixation with square nailing was done. In two patients, one with associated ipsilateral closed fracture shaft middle third of right femur was treated by IM interlocking nail and another patient associated with ipsilateral crush injury of right foot with metatarsal I and II fractures was managed by K-wire fixation and split skin grafting (**Table 3**). In the 4 Gustilo – Anderson type 2 fractures which were 1 oblique, 1 segment, transverse and 1 butterfly external fixator was removed after 6 weeks and intramedullary interlocking nailing was done. In 8 Gustilo –Anderson Type 3 A fractures which were 2 butterfly and 6 comminuted, the butterfly fractures were treated with intramedulary nailing 6 weeks after being in external fixator. The remaining 6 which were comminuted, 5 were treated with external fixator for 4 months followed by POP cast (PTB cast) for another 6 weeks. One of them showed signs of sclerosis of 1 to 2 fragments which were excised after 4 months. In the 8 cases of Gustilo – Anderson type – 3B all were comminuted fractures, 6 were treated with external with external fixator for 5-6 months followed POP cast for another months 2 cases showed. Signs of non-union and had cancellous bone grafting, after 6 months of external fixator application followed by POP cast above Knee next 2 months.

DISCUSSION

Seventy percent of patients in the present study had good results. All were male with mean age of 28years whereas in Thakur and Patanakar[12] study, females and males represented 16.5% and 83.5% respectively with mean age of 38 years suggesting higher level of activities and mobility in the these age groups. The present study documents road traffic accident as the cause of injury in all cases whereas on an average 85.9% and 87.3% road traffic accidents were recorded by Pedro AntichAdrover et al[13] and Thakur and Patankar[12] series respectively. An equal number of cases of Type III A and Type IIIB (40% each) and type II (20%) noted in the present study in comparison with Thakur and Patankar[12] series where 12 spiral (or) long oblique, 27 Transverse (or) short oblique, 40 comminuted fractures were documented. The present study also records 50% of the fracture middle third, 30% fracture distal third and 20% fracture proximal third while it was 78% middle third, 10% distal third and 4% proximal third from a study by Henley MB, et al[14]. In our series, 8 patients underwent split skin grafting (40%), 1 patient muscle pedicle flap (10%) and one case of type III A and 2 cases of type IIIB bone grafting where as in the Thakur and Patankar[12] series, skin grafting was required in 43 patients, 5 flap coverage and 44 cases (60.3%) of bone grafting. Superficial wound infection (20%) and pin tract infection (10%) were the common complications in the present study whereas superficial and deep wound infections of 42.2% and 16.1% respectively were noted in the series by Bhandariet al[15]suggesting infection rate was lower in the present study and was successfully managed with parenteral antibiotics.

CONCLUSION

Open fractures of tibia are quite common, because of its subcutaneous location, high energy trauma, which is quite often encountered during high speed moving vehicles, especially on national highway. The study shows that reasonable outcome may be attained in open tibial fractures with the external fixation technique allowing early definitive treatment. Complications are minimal with good range of movements in knee and ankle.

Competing interest: NIL

Author's contributions: NAGAKUMAR J S participated in acquisition of data, literature search and carried out analysis, interpretation, and drafting the manuscript. S S GUBBI, S B KAMAREDDY did acquisition of data and participated in drafting and revising the manuscript. All authors read and approved the article.

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