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ORIGINAL ARTICLE

MANAGEMENT OF COMPLEX OPEN FRACTURES: A PROSPECTIVE STUDY

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ABSTRACT: BACKGROUND: The incidence of Open fractures is on the rise, due to the increasing Road Traffic Accidents in India. In fact accidents are the leading cause of death in young, healthy individuals now. As the number of compound fractures are flooding the outpatient departments of all the major hospitals a viable and effective strategy has to be in place to manage these patients. The various treatment options available to treat these fractures and their effectiveness is the basis for this study. **MATERIAL & METHODS:** This study was conducted by our unit, from Department of Orthopedics and Traumatology, Osmania General Hospital/Medical College during September 2012 to September 2014. The study comprises of 40 patients who were treated during this period, the patients selected were with Compound fractures Grade III A and Grade III B of Femur, Tibia and fibula. Various modalities of fixation were used in the management of these patients depending upon the clinical condition of the patient. **CONCLUSIONS:** External fixation was the mainstay of these fractures. It may be a first aid procedure or a definitive treatment option. The other options like Primary Nailing, biological plating have their own indications. Secondary procedures do play their role in the effective management of these complex injuries. All in all the successful management of these limb / life threatening injuries lies in the initial management and early intervention, secure fixation of fractures, prevention of infection and reasonable covering of the wounds.

KEYWORDS: Gr III A, B compound fractures, External fixators, unreamed nailing, Ilizarov fixator.

INTRODUCTION: Injuries and fractures have become so common in the present day, the causes of fractures vary according to age groups as in younger population it is due to high energy trauma as in motor vehicle accidents and fall from height. In elderly, it is due to trivial trauma, secondary to generalized osteoporosis.

The tibia being the most commonly fractured long bone,[1] epidemiological studies suggest that motor vehicle accidents are the most common causes of tibial diaphyseal fractures, followed by sports related injuries. High energy trauma which imparts more kinetic energy that causes fractures which are often severe with associated soft tissue injury. Treatment options for tibial fractures vary according to the type of fracture, age group, bone density, soft tissue status and associated complications. Conservative methods used are casting or bracing for stable closed fractures.

Because of improper anatomical alignment and associated soft tissue injuries, these Conservative methods have become less useful. Operative techniques used are external fixation methods including Limb Reconstruction devices and internal fixation methods using intramedullary nailing and Plating.

The management of compound fractures of tibia is an enigma to orthopaedic surgeon. Numerous methods have been described and came out with varying results for the management of compound fractures of tibia. Controversy exists as to the optimal method of stabilization of open fractures of Tibia.

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External Fixation devices had been quite popular in the management of Compound fractures. In external fixation; fracture fragments can be realigned, compressed or distracted, without the need of opening fracture site. With improved components, and a better understanding of the principles, that govern their safe and effective use, external fixators have become indispensable tool in the hands of the experienced trauma surgeon.[2] Lately intramedullary nail is being used as the initial management of these fractures as external fixation devices are associated with complications such as communition, displacement, soft tissue injury and pin tract infections moreover wound management and skin closing procedures are easier with Intramedullary nailing. Percutaneous plating techniques[3] have also been used. Several studies showed that using plates showed excellent and good results. Indeed several trials are currently ongoing regarding use of plating in compound fractures.

AIMS AND OBJECTIVES: Preoperative assessment evaluating the age group affected, type of fracture, mechanism of injury, and associated soft tissue status and associated neurological injury.

Return of the injured extremity to full function in the shortest period of time possible.

To analyze the results of external fixation with respect to bony union, soft tissue coverage and with special consideration of knee and ankle movements, limb shortening.

To analyze the results of internal fixation with respect to bony union, soft tissue coverage and with special consideration of knee and ankle movements, limb shortening.

To study the post-operative complications such as infection, deformity/ mal-union.

MATERIALS AND METHODOLOGY: The patients studied are those with GRADE IIIB compound tibial shaft fractures, some with GRADE IIIB compound proximal tibia associated with supra-condylar fracture femur. All these forty patients were treated in the department of Orthopaedics, Osmania General Hospital during the period of September 2012 to September 2014.

Inclusion Criteria:

1. Grade IIIB compound fractures of tibia.
2. Grade IIIB compound fracture tibia proximal third along with supracondylar femur fracture.

Exclusion Criteria:

1. All poly-trauma cases are not taken into consideration.
2. Other associated long bone fractures.
3. Grade III C compound fracture and patients unfit for anaesthesia and surgery.

Initial emergency management at hospital[4]:

- Life preservation – ABC (Airway, Breathing, Circulation).
- Limb preservation.
- Infection avoidance.
- Functional preservation.

Gustilo,[5] Brugers,[6] Tscherne,[7] the AO-ASIF group and others recommend the following steps for open injuries.

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These goals can be achieved by following recommended steps;

- Treat all open fractures as an emergency.
- Perform a thorough initial evaluation to diagnose other life threatening injuries.
- Begin appropriate antibiotic therapy and continue for 2 to 3 days.
- Immediately debride the wound using copious irrigation.
- Stabilize the fracture.
- Leave the wound open for 5 to 7 days.
- Perform early autogenous cancellous bone grafting.
- Rehabilitate the involved extremity.
- The surgery should be done as soon as possible. The golden hours are the first six hours.
- A contaminated wound is considered to be infected after 6 hours.
- Minimum duration of an organism takes to establish in wound and start multiplying 6 to 8 hours.
- Resuscitation, stabilization of the patient, bandaging and splinting and a history including immunity to tetanus and of Diabetes mellitus, chronic steroid use, drug hypersensitivity and time of last meal should be taken.
- Proper radiological examination should be made.

Preparation for Surgical Debridement:

a. Stabilization and anaesthesia: Preoperative planning determine the order in which multiple fractures are treated. Open fractures often present unexpected surprise, therefore a full set of soft tissue and bone instruments must be made available.
b. Tourniquet: The surgeon should consider placing the non-inflated tourniquet on the limb because it may be necessary to control the severe haemorrhage encountered when a blood clot is removed from an unexpected major arterial injury. However the tourniquet should not be inflated either for visualization or to limit blood loss. Tourniquet inflation for 10 minutes or so followed by release results in capillary flush of skin. This may be helpful as an indicator for skin viability.

Treatment of Open Fractures: The treatment of open fractures of tibia required consideration of soft tissue, initial injury and treatment modality selected for fracture stabilization.

There are five keys for successful treatment.[8] They are:

- Radical debridement and pulsed lavage irrigation.
- Stabilization of fracture.
- Antibiotic therapy.
- Soft tissue coverage.
- Functional rehabilitation and presumptive bone grafting in high energy trauma and bone loss patients.

Irrigation and debridement[9,10]: The solution to pollution is Dilution: The wound should be thoroughly irrigated with copious amount of isotonic saline. Obtain cultures for identification of contaminating organism and sensitivity to antibiotics.

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Advantages of Irrigation:

- Initial lavage by flushing away blood and other debris cleans wound.
- Irrigation fluid floats in areas undetected otherwise.
- Lavage of the tissue restores its normal colour and facilitates determination of viability.
- Irrigation reduces the bacterial population.

Objectives of Debridement and Irrigation:

- Extension of traumatized wound for identification of the zone of injury.
- Detection ad removal of foreign material.
- Detection and removal of non-viable tissue.
- Reduction of bacterial contamination.

a. Skin and Subcutaneous Fat: An extensile incision is used that provides effective debridement visualization. The elliptical wound thus produced is usually closed with sutures and can even be left open for spontaneous closure, leaving a simple linear scar. The surgeon must be conservative in excision of the skin particularly where it is at premium. E.g. leg, foot, hand. Places where adequate skin is available, sharp excision of the contaminated and contused skin edge 1 to 2 mm into good quality skin with a sharp blade provides a good wound edge for subsequent closure. A traumatic skin flap that has a base to length ratio of mere 1:2 particularly if distally based, frequently it has a non-viable tip. If very large wounds are produced by loss of skin and subsequent coverage is expected to be difficult, it may be possible to harvest skin from the excised flap.

b. Fascia: Any non-viable, damaged and contaminated fascia should be excised. No marginal fascia should be left. Limited fasciotomy is indicated in all open fractures secondary to high energy injuries. If a defect in fascial layer is found and fasciotomy is indicated as part of debridement.

c. Muscle: Muscle because of its high water content it is subject to hydraulic damage. Necrotic muscle is the major problem for bacterial growth and poses a great danger in anaerobic infections. So the approach is when in doubt take it out, is the safest. Judgement of viability of a muscle is done by 4Cs: Colour, Consistency, Contractibility and Capacity to bleed.

d. Tendons: Tendon unless obviously severely damaged and contaminated are not a major problem for infection and if essential to function they should be preserved. Where coverage of tendon by some soft tissue is not possible preservation of the peritenon is essential for tendon survival.50 If the peritenon is soft, then a moist dressing is applied over it. It is kept moist till surgeon swings some soft tissue over it.

e. Bone: Whereas muscle tissue may mount a defense against invading bacteria, bone tissue is essentially defenseless owing to its relatively poor blood supply. In general small bits of cortical bone that are free of any soft tissue attachment should be removed. When a large bony segment that has soft tissue attachment, and it is bleeding, it should be retained.

Completely devascularised bone segments should be debrided. Major segments or articular surface even if avascular should be retained regardless of wound type when salvage of the involved joint is to be attempted.

However retention of a large segmental avascular fragment of bone may lead to non-union. Also it is better to deal with the reconstruction of a large segmental defect than to allow chronic

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infection to set in resulting in chronic osteomyelitis which may lead to even more bone loss. Viability of bone can be assessed by signs of bleeding at bone edge.

f. Joints: Any wound that enters a joint mandates exploration. It may be better combine debridement of the wound, with arthroscopic examination of the joint, if adequate arthrotomy is not possible. Intrarticular penetration can be ruled out by injecting sterile saline or methylene blue to distend the joint capsule watching for fluid extravasation from the open wound.

g. Nerves and Vessels: Nerve injury amendable to repair should be sutured before delayed primary closure. Brisk small vessel or arterial bleeders encountered during debridement require immediate ligation or coagulation. In large vessels than carrying out immediate end-to-end anastomosis or vein grafting it may be better to insert a temporary shunt. This permits irrigation and debridement and stabilization of the bone before final vascular repair.

h. Fasciotomy: After arterial repair for complete ischemia to the distal limb, massive swelling distal to the site of repair is very common. If there is any doubt about indication for fasciotomy, it should be done prophylactically.

i. Elevation: Persistent or increased swelling may keep tissues turgid and wound surface moist thereby preventing delayed primary closure. Edematous tissue increases tension on the suture line and may lead to marginal wound necrosis. Limbs must be elevated in a manner that is comfortable for the patient and guarantees continuous elevation at the level above heart.

j. Antibiotics[11]: Antibiotics for open fracture wounds should not be considered prophylactic but therapeutic because bacteria contaminate these wounds. The role of antibiotics is to kill the residual organism and atleast, inhibit their growth to the point where host protective mechanism can eradicate them. The duration of antibiotic administration is controversial. They are given for 48 to 72 hours and if signs of infection or drainage occur at any time wound is cultured and treatment is based on those culture reports.

Numerous antibiotics can be incorporated in polymethyl methacrylate (P.M.M.A.) to provide sufficient bactericidal levels in the surrounding fluids and tissues.

Limb salvage versus amputation[12]: Lange and associated have published absolute and relative indications for immediate amputation.

a) Absolute indication: A type IIIC tibial fracture in which vascular repair is required for salvage of the extremity and there is complete resection of the posterior tibial nerve and the limb is non-viable.

b) Relative indications:

1. When there is vascular injury requiring repair and warm ischaemia time over 8 hour with minimal viable tissue remaining.
2. Even after revascularization limb is so severely damaged that function is less satisfactory than that afforded by the prosthesis.
3. Severely injured limb in prevalence of severe debilitating chronic disease where limb preservation is a threat to patient life.
4. In a limb in which severity of the injury demands several operative procedures and a prolonged reconstructive time.
5. In a military or mass casualty.

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6. In a patient with severe multisystem injury in whom salvage of a marginal extremity may result in systemic load of necrosed tissue.
7. A replantation, where the function expected does not justify salvage.
   Helfet[13] et al. found mangled extremity severity score (MESS) to be very useful in making decision. In their study limbs with scores of 7-12 ultimately required amputation. Scores of 3 to 6 resulted in viable limbs. Attempts to modify MESS results in NISSA, nerve injury, ischaemia, soft tissue injury, skeletal injury and age.

METHODS OF STABILIZATION OF OPEN FRACTURES OF TIBIA: Stabilization of the Bone:
The Goals are:

- To restore length and alignment of long bones.
- Restore articular surfaces displayed by fractures.
- Allow wound access to the traumatic limb.
- Facilitates further reconstruction procedures.
- Allow early use of the limb.
- Facilitate fracture union and return of function.
- Avoids further injury to soft tissues.

The various modalities of treatment of open fracture of tibia are:[14,15]

- Closed reduction with long leg pop cast application with window made for drilling.
- Pins and plaster technique in which transfixing pins (e.g. Steinmann pins) are incorporated in a long leg pop cast.
- Internal fixation using:
  a. Plate and screws: e.g. Dynamic compression plates, static compression plate, neutralisation and buttress plate.
  b. Interlocking, intramedullary nails either by open or closed methods or reamed or undreamed nailing.

4. External fixator such as pin fixators, ring fixators and hybrid fixators (using wires and half rings). External fixation is most often indicated for type IIIB and type IIIC open fractures of the tibia.

Prognosis: Time for union in most closed low energy fractures ranges from 10 to 14 weeks. High energy fractures are usually healed in 12 to 26 weeks. Open fractures on an average requires 16 to 20 weeks. With type IIIB and type IIIC open fractures requires 30 to 50 weeks for consolidation. Long term results depend on limb length restoration and range of knee and ankle motion. Joint motion is dependent primarily on the length of immobilisation or on the initial injury is controversial. If complication of infection, non-union, vascular disruption, or reflex sympathetic dystrophy do not ensure, return to previous employment is the rule. Return to recreational sports depends on flexibility and strength of rehabilitation, although long term studies have suggested difficulties with knee and ankle motion for purely shaft fractures. Future functional difficulties cannot be predicted on the basis of degree of malunion.

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Complications:

- Skin loss.
- Neuro Vascular injuries.
- Bone defects16.
- Fat embolism.
- Infections.
- Compartment syndrome.
- Joint stiffness and ankylosis.
- Delayed and non-union.
- Traumatic arthritis.
- Post-traumatic dystrophy.
- Claw toe deformity.

RESULTS: AGE INCIDENCE: (Table & Graph no: 1): Majority of our patients were between 31-40 years.
SEX INCIDENCE: (Table & Graph 2): There were 30 males and 10 females in our study, almost three times more common in males.

SIDE INCIDENCE: (Table & Graph 3): In majority of our cases right side was involved more.

LOCATION OF FRACTURES: (Table & Graph 4): Middle third of Tibia was involved in the majority of patients (60%).

Fracture Pattern: (Table & Graph 5)**:** Of all types of fractures, Transverse, short oblique, long oblique types were more common.

Timing of operative intervention (Table 6): In our series, maximum number of cases were fixed within 1 week of sustaining injury (75%) and (15%) of cases were operated during second week and rest between second and fourth week (10%).

Mode of Trauma: (Table 7) In our study, most common cause was road traffic accident, 36 out of 40 cases (90%). All were due to high velocity injury.

Treatment Modalities (Table 8 & Graph 6): In our study majority of patients (60%) were treated with external fixation.

Secondary Procedures (Table 9 & Graph 7): Skin grafting was the commonest secondary procedure in our series.

HOSPITAL STAY: The average hospital stay of the patients was 48 days. The longest stay in hospital was 98 days and minimum stay was 15 days.

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RESULTS: The results were classified as good, moderate and poor depending upon the fracture union, degree of deformity, degree of shortening, range of motion at neighbouring joints. The degree of deformity and limb length discrepancy was assessed using the modified Anderson and Hutchin's criteria

Results	Shortening	Grade of Deformity in angulation
Good	<1cm	Upto 5°varus / valgus Upto 10° Anterior /Posterior
Moderate	1-2cm	5-10° varus / valgus 10-20° Anterior / Posterior
Poor	>2cm	> 10° varus / valgus > 20° Anterior / posterior Angulation

Modified Anderson's and Hutchin's criteria[17]

The ankle and knee movements were graded as:

Full range – Normal.

Significant loss of movement:

- In the knee: loss of extension upto ≥ 10°.
- In the ankle: loss of 25° but < 50° of flexion / extension.

Insignificant loss of movement: Anything less than the normal range of motion.

Severe loss: Both in knee and ankle with loss of > 50° of flexion ad extension.

The results were classified as:

Good: No pain, no swelling, no tenderness, deformity (Angulation) < 5° varus/valgus; <10° anterior / posterior, limb length discrepancy <1cm, knee and ankle movements full range and painless walking, sitting cross legged and squatting normal.

Moderate: Minimal deformity (angulation) 5-10° varus / valgus, 10-20° anterior / posterior, limb length discrepancy 1-2 cm, insignificant loss of motion at knee and ankle.

Poor: Deformity (angulation) >10° varus/valgus, >20° anterior / posterior angulation; limb length discrepancy > 2 cm, significant loss of motion at knee and ankle.

RESULTS	NO. OF CASES	EXTERNAL FIXATION	LRS	ILIZAROV	IM NAILING	PLATING
GOOD	24	14	1	5	3	0
MODERATE	9	6	1	1	1	1
POOR	7	4	1	0	1	1

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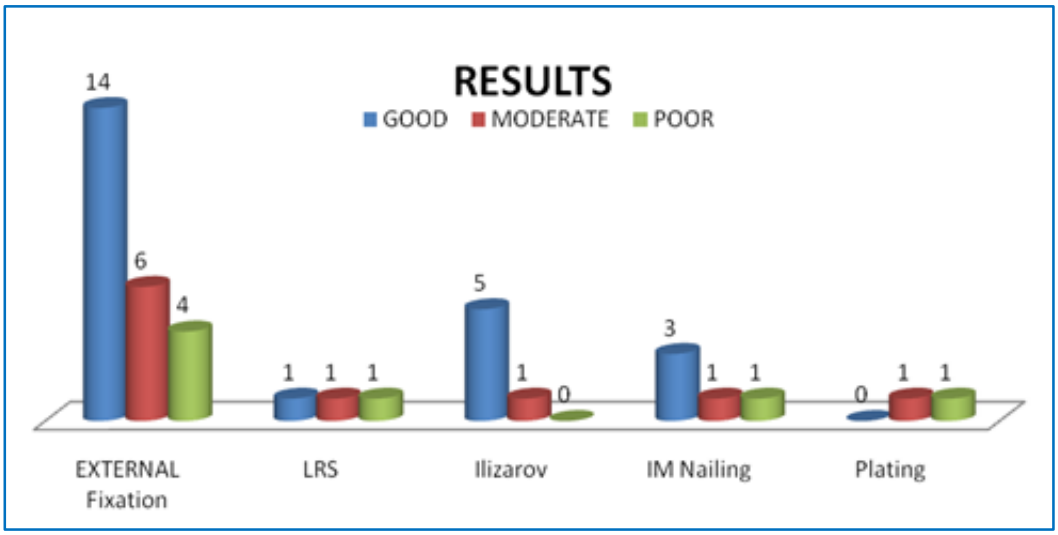

RESULTS	EXTERNAL FIXATION	INTERNAL FIXATION
GOOD	20(60.6%)	3(42.8%)
MODERATE	8(24.2%)	2(28.5%)
POOR	5(15.15%)	2(28.5%)

OBSERVATIONS:

Age Incidence: In the present study, all the patients included under the study were between 20-50 years of age. The maximum number of patients were in the age group of 31-40 years of age including 20 patients. The mean age in our study was 34 years approximately. While in Thakur and Patankar[18] study the mean age was 38 years.

Sex Incidence: In the present study, 75% of the patients were male, which may suggest higher level of activities and mobility among males than females. The female patients accounted for the rest 25% of study group. While in the study done by Anand J Thakur and Joy Patankar there were 83.5% males and 16.5% females.

Mode of Injury: In our study, road traffic accidents was the cause of injury in majority of cases (90%) except in four patients it was due to fall from height. While in the study conducted by Pedro Antich Adrover et al.,[19] road traffic accident was the cause of injury in 81.9% of patients in group A and 90% of patients in group B. In Thakur and Patankar series, 87.3% of open fractures were caused by road traffic accidents.

Site of Fracture: In our series of study, 60% of the fractures were in middle third, 17.5% fractures were at proximal third and the 15% fractures were at -distal third & remaining7.5% fractures include that of femur distal third region. While in the study done by Henley MB, Chapman JR, Agel J et al.,[20] 4% fractures were at proximal third, 78% of fractures were at middle third and 10% of fractures were at distal third.

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External Fixation: In a total of 40 patients in this study 24 patients were treated with uniplanar universal external fixation system. In the treatment of fractures it is not known that what degree of rigidity is optimal for bone healing. It is recognized clinically that the amount of external callus formed is related to the amount of movement of the fractured ends. It has been shown that rigid internal fixation can inhibit external callus completely(Anderson 1965;Schenk and Willenegger1967).[21] union by a bridge of external callus has definite advantages, especially in severe injuries such as those for which we have been using external fixation.

Austin(1977),[22] has pointed out that all grades of tibia fractures take longer to unite if treated by rigid internal fixation than they do with conservative methods; moreover the difference is most marked in the severe group of fractures, which also have highest incidence of nonunion. It seems logical therefore, particularly when treating complicated fractures, to encourage this natural healing process not to suppress it by rigid internal fixation or by completely rigid external fixation.

In this study 24 patients treated with external fixator 16(67%) of them required secondary procedures either for soft tissue or bone healing. 8(33%) of them were treated completely with external fixator as the primary modality. In 14(58.33%) patients fractures healed without any secondary procedures. In 10(41.66%) patients fracture healing required secondary procedures as intramedullary nailing in 6,plating in 2 and ilizarov in 2, bone grafting in 1 patient. 13(54.1%) patients required secondary procedures for soft tissue healing, split skin grafting in 11 and myocutaneous flap in 2 patients.

In these 24 patients, 8 cases there have been pin tract infections, most of the pins are in particular nearer to raw area, 6 cases have been associated with pin loosening which have been replaced. However in 8 cases of pin tract infections 6 cases were superficial infections and healed by keeping them appropriate antibiotics and pin care. In 4 cases shortening was observed, however in 2 cases it was insignificant. In 2 cases mild equines deformity was noted. 2 cases went in to malunion both in mild varus one 7^{o} and other 8^{o}.

1 case went into infective non-union and went in to below knee amputation In this study out of the 24 patients, 14(58.3%) showed good results,6(25%) showed moderate results and 4(16.6%) showed poor results as evaluated using modified Andersons and hutchinsons criteria.

A study published in journal of bone and joint surgery by Paul tornetta,[23] Marc Bergman, Neil Watnik, Gregg Berkowitz, Jeffrey Steuer on grade III b compound fracture management of tibia 14 patients were treated with external fixators, there were 3 pin tract infections, which required unplanned removal of fixator one of these patients developed local osteomyelitis requiring sequestrectomy and intra venous antibiotics two patients had superficial infection which cleared of after a short course of intravenous antibiotics and wound care two fractures have healed with mild varus malunion. Two patients required secondary bone grafting, and there were no late amputations
We have also used a novel technique of incorporating ilizarov ring to the external fixation frame in the management of injuries associated with wound in the posterior aspect of the leg and knee, so that the raw area will be well elevated above the ground level and this also provides adequate wound drainage with adequate access to the wound dressing.

ILIZAROV METHOD: In the present study 6 cases of Gr IIIb compound fracture tibia have been treated with ilizarov fixator primarily. The use of the ilizarov apparatus has been widely reported for such congenital and acquired problems as club foot, radial club hand, joint contracture, leg length

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discrepancy, and infected and non-infected nonunion of fractures (Ilizarov and soibelman1969;[24] volkov and oganesian1975;[25] monticelli and spinelli 1981;[26] messina 1988,[27]).

Ilizarov can also be used effectively in the treatment of compound fractures with or without bone loss.it allows simultaneous treatment of bone loss, infection, non-union, and deformity.

In the present study, 6 cases of Gr III b compound fracture tibia were treated with Ilizarov, out of which 3 cases are proximal 1/3rd tibia fractures and 3 cases are middle 1/3rd fractures associated with some comminution and some insignificant bone loss. Out of the 6 cases 5(83%) cases showed good results and 1(17%) showed moderate result evaluated by modified Anderson and hutchinson criteria

In the study carried by F. Dagher and S.Roukoz,[28] 9 patients were treated with ilizarov out of which 6(100%) cases are Gr III b compound fracture tibia and results were good in all the 6 cases.

In the present study, out of 6 cases 3 cases reported after 2wks with prior infection. In 5 cases wound management have been achieved by split skin grafting and there was pin tract infection in 1 case which was dealt by replacing the pin in a different track and by keeping on intravenous antibiotics and wound management.

Mc coy, Chao and Kasman (1983),[29] have compared the mechanical properties of several external fixators. They showed that the ilizarov type of device had the lowest overall stiffness but high resistance to antero-posterior bending strains. Its design would appear to allow axial compressive forces at the fracture site. In this respect it provides a dynamic osteosynthesis system which allows early mobilization and allows weight bearing contact between the fracture fragments. The follow up period in the present study was ranging from 6m to 18 and bony union was achieved in all cases.

In the study carried by F. Dagher and S. Roukoz, follow up period was 30 months and bony union was achieved in all 9 cases that were studied.

Limb Reconstruction System (LRS): In the present study Gr III b compound fractures of tibia with hannover grade II and Gr III, where wound may require secondary wound closure procedures and the patient being affordable are selected.

In the present study, 3 patients were treated with LRS, among which split skin grafting was required in 1 case and myocutaneous flap in 1 case and 1 case healed by secondary intention. While in the Thakur and Patankar series skin grafting in 43 patients and 5 required flap coverage 16 wounds were managed by delayed primary or secondary closure. In the Tornetta III et al.[11] series of tissue cover was obtained in each case with a muscle flap or skin graft. In Hans P Granhed and Abbas H Karladani[30] series, out of 9 type III compound fractured patients. A free vascular flap in 5 patients and a local flap repair in 4 patients corrected the soft tissue loss. All soft tissue transfers were successful.

In the present study none of the 3 cases required bone grafting\While in Thakur and Patankar series bone grafting was done in 44 cases (60.3%)

In the present study, one patient needed proximal corticotomy and lengthening. In the study by Hans P Granhed and Abbas H Karladani, all 9 patients of type III fractures was treated by proximal corticotomy and lengthening. Equal limb length was achieved in them.

In the present study, none of the patient required pin replacement. In the study conducted by Hans P Granhed and Abbas H Karladani on 9 type III compound fracture patients, one patient required the pin replacement and 2 required correction of external fixator.

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In the present study, the common complication were pin tract infections and we treated these pin tract infections with suitable parenteral antibiotics after culture and Sensitivity. In the series by Bhandari et al.[31] superficial wound infection was seen in 42.2% of patients, deep infection in 16.1% of patients. In the present study, pin tract infection occurred in 30% of patients and deep infection in 0% of patients.

In the present study out of the 3 cases 1 case showed good result, 1 case showed moderate result and 1 case showed poor result as per modified Anderson and Thomson criteria. 1 case showed equines deformity and 1 case with insignificant knee Stiffness.

Intramedullary Nailing: In the present study, we have chosen unreamed intramedullary nailing for 5 cases with following features.

Patients presented with in 6hrs post trauma, with minimal contamination i.e; belonging to grade II hannover system, with m/3rd and m/3rd-d/3rd junction fractures with minimal comminution, transverse or short oblique fractures.

The unreamed tibial nailing is reported to have definite advantages over the reamed nailing. Unreamed nailing in experimental studies has been found to cause less reduction in cortical circulation as compared to reaming of the medullary canal. Klein et al[32]. Reported 31% reduction of cortical circulation using unreamed nail as compared to 71% reduction after reaming. Reaming of open fractures has been found to spread the contamination from open wound along the medullary cavity and to strip small fragments of bone from the soft tissue attachment. Reaming has also been reported to slow the revascularisation and delay osseous union. Cortical necrosis is less likely to occur with a loosely fitted intramedullary nail than a snugly fitted reamed nail.

Despite thorough debridement and adequate soft tissue coverage, there was an overall incidence of infection in 1 of 5 cases.

Yokoyama et al.[33] reported a mean union time of 15 months in more than 50% of type-III fractures, whereas the overall mean union time in their series was 6.6 months, which is comparable with that in the present study (8 months). Comparable incidences of delayed union and bone graft supplementation were also reported in other series. An 8-mm diameter nail was used in 3 cases in the present study, probably because of the narrow medullary canal of relatively small-built Indian patients as compared to their western counterparts. Because the mechanical strength of the nail is proportional to its diameter, these 8-mm diameter nails are relatively weak, particularly in bending mode. The nails at the site of locking holes are also more prone to break because stresses are concentrated at the screw hole junction and at the sites of the empty holes not filled by bolts. Minimal endosteal contact of these unreamed nails further concentrates the stresses at the screw hole junction, which may be responsible for the nail failure or screw breakage. However in the present study no nail or screw breakage was documented.

Similarly, Ruiz et al.[34] Reported a 1.8% of nail failure in a series of 520 patients treated by intra-medullary tibial nail; 4 (66.7%) of the 6 nail failures occurred in patients using 8-mm or 9-mm diameter nail; none of the 12-mm or 13-mm diameter nail failed.

In our series, the incidence of screw breakage was 0%, the incidence of screw failure can be brought down, by using 2 screws each for both proximal and distal locking to make the assembly rigid, as advocated by Kneifel and Buckley.[35] Hahn et al. advocated a cautious approach for such fractures by filling all the screw holes with bolts to reduce concentration of stress distally. Regaining

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the length of the traumatised and swollen muscles after intramedullary nailing with intact or partially ruptured fascial envelope may have acutely elevated the compartment pressure.

Blick et al.,[36] reported 9.1% incidence of compartment syndrome in open fractures treated by intramedullary nailing. A high level of suspicion is required as the incidence of compartment syndrome may be higher; especially under the prevalent misunderstanding that compartmental auto-decompression would occur after open fractures of the tibia.

In the present study one patients had anterior knee pain and required occasional analgesics. Court-Brown et al.,[37] reported 36% incidence of anterior knee pain and advocated techniques of using a more proximal and lateral entry point, hyperflexing the knee during nail insertion, and extending the knee during screw insertion to reduce the incidence of anterior knee pain. We adopted only the techniques of hyperflexing the knee during nail insertion and extending the knee during screw insertion. We had no experience of using a more proximal and lateral entry point, although theoretically it may cause less irritation and damage to overlying tendon.

In the present study, 3 cases (60%) showed good results, one case moderate and one case poor result as evaluated by modified Anderson and Thomson criteria.

Plating: In the present study we have done plating in 2 cases which are floating knee injuries with gr III b supracondylar fracture femur and grIIIb compound proximal tibia fractures, both of which presented early within 6 hrs post trauma and with less contamination hannover grade II.

A similar study was published in journal of orthopaedics, traumatology and rehabilitation in vol. 7, by neerajmishra, Chandra prakash pal, karuna Shankar dinkar, Harishkumar, Pulkesh singh, RK Goyal[38],where they studied primary plate osteosynthesis in open fractures where a total of 12 patients were studied out of which 2 cases were GRIIIB compound fractures of tibia. out of which 1 case showed satisfactory result and 1 case showed poor result. In the present study, 1 case showed moderate result and 1 case showed poor result.

CONCLUSIONS:

1. Open tibial shaft fractures are more common in males of 3rd & 4th decade. Most common mode of injury is motor vehicle accidents. Most common fracture patterns are transverse, short and long oblique.
2. Surgical outcome is directly proportional to the restoration of length, rotation, angulation, and good stabilization of fractures.
3. External fixators are the choice of fixation in open fracture of tibia especially in comminuted and severe Gustilo-Anderson type IIIB injury, especially where internal fixation is not feasible. Soft tissue procedures like skin grafting, myocutaneous, muscle pedicle flap repair can be easily accompanied with external fixator in position.
4. LRS external fixation with the complexity of frame configuration provide good Fixation
5. Ilizarov has got its own advantage of its applicability in injuries presented late as infection can be managed at the same time and patient can be mobilized from the 1st post op day.
6. The key procedures to minimise deep infection are adequate debridement, early soft-tissue coverage, and adequate fixation.

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