MATERIAL AND METHODS
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The study was conducted in the department of Orthopaedic Surgery, M.L.B. Medical College, and Hospital Jhansi during the period from August, 1993 to November, 1994. Twenty two cases of open fractures coming to emergency department of the hospital were included in the study. Most of the patients did not receive any treatment before coming to the emergency department. Each patient was subjected to clinical and radiological examinations along with some necessary pathological investigations before starting the operative procedure.

Patients with open fractures may be a polytrauma victim. A polytrauma patient has involvement of two or more systems in the form of injuries of head, chest, pelvis or extremities. The management of patient was started as soon as the patient was brought to the hospital. Patient was hospitalised and after taking history, thorough general, local and systemic examination was done. Patients with altered consciousness were examined to rule out head injury.

Another feature of open fractures was that there were varying degrees of soft tissue damage and varying severity of bone involvement. Open fractures were classified on the basis of severity of soft tissues and bony
injuries and mechanism of injury (Gustilo-Anderson classification, 1976). It determines the nature of treatment, outcome of the treatment and usually the course of events that follow.

The following principles were essentially used for successful treatment of open fractures.
1. All open fractures were treated as an emergency.
2. Thorough initial evaluation to diagnose other life threatening injuries.
3. Appropriate and adequate antibiotic therapy.
4. Adequate debridement and irrigation.
5. Stabilization of open fracture by intramedullary nailing or external fixator as the need be.
6. Appropriate wound coverage.
7. Rehabilitation of the involved extremity.
8. Rehabilitation of the patient.

The involved leg was examined and wound was described in detail - size, skin loss, degree of contamination (presence of foreign materials and exposed bone). A detailed examination of the neurovascular structure was done at the same time. The wound was then cleaned with saline and providine iodine solution, dressed with sterile gauze and the injured part was splinted so that movements of fracture fragment causing further damage could be prevented. The wound remained covered till the patient was shifted to the operating room. Proper and accurate
documentation of history and physical finding of the patients on admission was done in all cases.

**Appropriate and Effective antibiotic therapy**

Pre-operative culture of wound prior to first handling was taken and then appropriate antibiotics were started. Injection ciplox 100 ml I/V 12 hourly for 2 days followed by capsules ciplox 500 mg 12 hourly was used with injection Gentamicin 60 mg/8 hourly and injection metrogyl 100 cc I/V 8 hourly as required.

**Tetanus Prophylaxis**

Tetanus prophylaxis was indicated in all open fractures. Tetanus toxoid and human gamma globulins were used in every case. Tetanus toxoid and gamma globulin (600 units) were given by separate syringes and at separate sites.

Appropriate X-rays were taken and necessary investigations were performed, then surgical management of the wound was started.

The pre-operative evaluation of patient can be summarised as follows:

1. General interrogation - Name, age, sex, address, occupation, mode of injury and duration of injury.
2. General assessment of vital parameters - general condition, pulse, B.P. and routine examination of other systems for fitness for anaesthesia and operation.
3. Local examinations including examination for associated neurovascular involvement and associated injuries.

4. Radiological examination (A.P. and lateral view including neighbouring joints) to know the site and type of fracture, so that nature of stabilization (fixation) can be decided.

5. Investigations - Hb, TLC, TLC, Urine for albumin and sugar.

**Surgical Management of soft tissues (Debridement)**

After anaesthesia, (either regional or general), the wound was irrigated (without scrubbing) with saline, foreign materials from wound were removed.

After painting and drapping, the debridement was started. Debridement included exploration of wound, removal of nonviable and devitalized tissues. All the tissues with gross contamination and with questionable viability were removed. Whenever needed, the wound was extended in order to remove dead skin, muscles or foreign bodies. The following structures, which are debrided, are discussed separately.

1. Skin
2. Subcutaneous tissue
3. Fascia and tendons
4. Muscles
5. Bones

**Treatment of Skin**

All nonviable and macerated skin was removed.

Small wounds in type I and type II open fractures were
elliptically enlarged, excising dead or frayed skin edges. Skin circulation was determined by skin colour. Skin edges of wound of an open fracture were excised till a bleeding edge was obtained. When a large area of skin had been lifted from the deeper tissue and it was devoid of blood supply, it was replaced after surgical toilet. Some part of it survived and later on slough was excised and split skin grafting was done in a clean field.

**Care of subcutaneous tissue**

All necrosed subcutaneous fat, which acts as a nidus for the growth and multiplication of bacteria was removed.

**Fascia and Tendon**

The contaminated and devitalized fascia was excised completely without fear of causing a residual functional deficit. The deep fascia was incised to relieve tension of compartment of the leg and to remove the collected blood clot, so that swelling gets accommodated and muscle could recover without strangulation and ischemia. Paratenon contains the main blood supply of the tendon and was preserved to maintain tendon viability.

**Muscles**

Scally et al (1956) in an excellent clinical and histological study determined four criteria of muscle viability:
1. **Consistency** : Live muscle is firm and resilient. A dead muscle picked up with forceps is friable and easily fragmented, lacking the firm and elastic consistency of live muscle.

2. **Contractibility** : Live muscle contracts or retracts or pulls away when cut, pinched or stimulated.

3. **Bleeding** : Live muscle bleeds when cut, indicating muscle viability.

4. **Colour** : Normal muscle is beefy red in colour. Colour becomes dark in a devitalized muscle.

The dead muscles were excised after deciding the viability of muscles based on the criterion given above. Muscles with questionable viability were also excised.

**Foreign Metal/Material**

Gun pellets or bullets, dust, cloth pieces and any other foreign material were removed.

**Bones** :

Small, free, devitalized cortical bone fragments without soft tissue attachment were removed. On the other hand, large fragments even when without any soft tissue attachment, were not removed, because they provided stability and bridging. Any bony fragment with a vascular
soft tissue connection was thoroughly cleaned, debrided and retained.

Fracture ends were exposed and the clot, and any foreign materials such as dirt, clothing or other contaminated materials were removed.

Final irrigation was done with normal saline mixed with antibiotics.

Debridement and irrigation were repeated under adequate anaesthesia during next 24 to 48 hours if necessary, because in most instances, even an experienced surgeon, cannot recognize varying degrees of tissue viability at the time of first debridement. All devitalized soft tissues found at subsequent debridement were removed to prevent settlement of the infection in the wound.

Stabilisation of the Open Fracture

After adequate debridement stabilization of bone fragments was done. In this study we used 'K' nail for intramedullary fixation if the wound and fracture anatomy permitted us to do so i.e. Grade I compound fractures. It was done as an elective procedure in the earliest routine O.T. available. In the meanwhile, after thorough debridement and surgical toilet, the limb was immobilised in a long leg slab. For severe soft tissue and bony injuries Grade II and III fractures (Gustilo and Anderson classification). The AO type of tubular external fixator was used as a primary procedure done in emergency O.T. at the earliest possible.
Wound Coverage

Wound coverage in open fractures has always been the subject of controversy. Primary closure, delayed primary closure, secondary closure and grafting were the various means which were used for the coverage of wound.

SURGICAL TECHNIQUE (For bone stabilization)

Intramedullary Nailing

- Patient was given general or spinal anaesthesia and part painted and draped.
- The limb was suspended from the edge of table to flex knee to 90°.
- A vertical incision (2") given just medial to tip of tibial tuberosity and periosteum incised and elevated.
- Opening made into the medullary canal with a curved Kuntscher awl.
- Guide wire passed from proximal to distal fragment as the fracture site is held reduced by manipulation.
- Reaming not done to avoid risk of infection.
- Appropriate size nail inserted over the guide wire and hammered across the fracture site into the distal fragment.
- Proximal wound closed.
- A/K post operative plaster slab applied temporarily to elevate post operative pain.

External Fixator

A unilateral uniplaner frame was used if fragment
were in good contact and with minimal or no comminution. Schanz screws were passed at right angles to medial surface of tibia. A unilateral biplaner frame was used in comminuted fracture with 60-90° angle between two planers.

- Patient was given general or spinal anaesthesia and part painted and draped.
- Thorough debridement was done.
- Cutaneous stab incision given large enough that the triple trocar can be inserted down to bone.
- In hard thick cortical bone of diaphysis 3.5 mm drill was used for predrilling. The pilot hole can be prepared with 4.5 tap if required.
- Optionally a 3.2 mm drill bit with 4.5 mm tap can be used.
- Thread length measured with the help of depth gauze.
- Schanz screws (4.5 mm) are inserted with the help of 'T' handle until screw tip pierces the opposite cortex and not far beyond.
- Fracture 'site is reduced without much disturbing the local vascularity. Distractor was used when required.
- The tubular rods are connected to Schanz screw with the help of universal clamps and nuts tightened securely.
- Stability checked.
- Skin tension around screws released with the help of scalpal to avoid necrosis and infection.

POST OPERATIVE CARE

Post operatively, patients were watched for vitals, limb circulation, soft tissue status and necessary action
was taken. External support, if necessary, was used in the form of plaster/splint after intramedullary nailing.

Daily dressing was done in case of type III fracture. Frequent dressings were not required in type I and II fractures.

Antibiotics were given according to the report of culture and sensitivity. Culture was taken just after removing the sterile dressing from the wound. When wound was small, window was cut if the complete plaster was given.

Patients were discharged when the wound healed or when patients had facilities for sterile dressing near their residence.

Follow up

After discharge from hospital, the patients were called for follow up at regular interval. When the wound was present at time of discharge from the hospital, the patient was called every fortnightly for inspection of wound and needful soft tissue reconstruction procedures. When soft tissue healing was completed then patient was called on once in a month.

At each follow up, patient was examined for sign of soft tissue and bone healing and for signs of complication e.g. delayed union, osteomyelitis, muscle contractures, joint stiffness and necessary procedures were performed. Sequestrectomy and bone grafting were performed whenever required.
Rehabilitation of the involved extremity

The rehabilitation of the injured patients was planned and started along with treatment of open fracture. Early external fixation allowed early joint motion above and below the fracture site and also allowed muscle exercises as soon as possible with minimal discomfort. Other extremities were also strengthened in order to facilitate the ambulation programme later on.

Rehabilitation accomplished three objectives:

1. Prevention of muscle atrophy.
3. Improvement of circulation in the extremity and around the fracture site.

Patient was periodically assessed clinically as well as radiologically, partial weight bearing was started early in cases in which good stability was achieved, in cases with fair stability partial weight bearing was started early after given PTB POP cast initially for first 6 weeks, while in cases in which poor stability achieved, they were immobilised by above knee POP cast for 5 weeks then partial weight bearing started after given PTB cast for 6 weeks, full weight bearing was allowed after clinical and radiological union.

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