MATERIAL AND METHODs

At Rajindra Hospital and Govt. Medical College, Patiala after taking the permission from the ethical committee 30 cases of compound fractures of tibia were selected, treated and followed up in between the time period of November 2018 and October 2020 under the department of Orthopedics.

Inclusion criteria

1. Compound fractures of tibia
2. Extra-articular fractures tibia
3. Ages between 18 years to 60 years
4. Type 2 and 3 (A and B) open fracture classified by Gustilo-Anderson
5. Skeletally mature patients

Exclusion criteria:

1. Skeletally immature patients.
2. Ages less than 18 years and more than 60 years.
3. Type 1 and Type 3C Compound fractures classified by Gustilo-Anderson

Materials

1. Radiolucent operating table

2. C-Arm machine

3. General instruments and LRS[39,40]

This instrumentation has got four models.

1. Long model – 500 mm
2. Standard model – 400 mm
3. Short model – 200 mm
4. Pediatric – 100-150 mm

We are using standard and short model. It has got:

1. Railing: made up of hard carbon, the function of this is to equalize the lever of the bone.
2. Connecting clamps which are three in numbers, each clamp has got 8 mm 3 threaded bolts, two in the front and one in the back of clamps which is connected to railing.

3. Compression and distraction unit.
4. Schanz pins 6 mm long threaded depending upon diameter of the bone.
5. Allen key.
6. Spanner 14 mm.
7. T-clamp: It can be attached to either end of rail. It is not a movable one, has got its own Templet.
8. Dyna ring is locked to the rail with the silicon cushion facing the clamp, which has been unlocked for dynamization and it permits only limited dynamization of fragment to safeguard the collapse of fragments. So, it allows earlier conversion from a rigid to dynamic mode and corresponding reduction in the neutralization period.
9. Fracture reduction forceps.
10. Power drill with bits.
11. T handles.

Methodology

Primary management-

When Patients were presented at emergency department of Rajindra hospital-

- Thorough examination was done to rule out any other systemic injury like head injury, cardiorespiratory and abdominal status.
- Patients with hypovolemic shock were treated with IV fluids like plasma expanders, dextrose, normal saline, ringer lactate solution.
- Immediate intravenous antibiotics and intramuscular tetanus toxoid, tetanus immunoglobulins were given.

Once the patient became hemodynamically stable, clinical evaluation and primary wound debridement was done under local anaesthesia with 5-6 litre of normal saline, betadine and hydrogen peroxide were used to clean the wound. The patient was given splintage of the limb, anti-inflammatory drugs and analgesics according to the needs.

- Detailed history was recorded as per the proforma attached, after that patient shifted to radiology department for X-rays.

Pre-operative preparation:

- Wounds were graded according to Gustilo-Anderson's classification as Type 1, 2, 3A, 3B and 3C based on the size of wound, degree of soft tissue injury, and level of contamination, degree of bone injury and presence or absence of neurovascular injury.
- Pre-operative counselling of the patients and his relatives regarding the method of treatment and prognosis was done and consent was taken.
- Complete preoperative radiographic assessment was done and preoperative surgery plan was prepared. Local preparation of part was done by shaving and painting with 10% betadine.
- Appropriate intravenous antibiotics were given immediately before operation or during operation and were continued following operation.

In our series, we have excluded type 1 fracture as they were treated with primary intramedullary interlocking nailing and type 3C compound fracture as they needed vascular surgeons.

Postoperative Management:

- Static quadriceps exercises & toe movements, as tolerated were started from the 1st postoperative day.
- Ankle and knee mobilization was started from 2nd postoperative day.
- Intra-venous antibiotics were given for 5-8 days followed by a course of oral antibiotics for 5-7 days.
- Analgesics were given as per need.

Protected full weight bearing was allowed once the pain was tolerable usually at postoperative day 5th.

- Regular antiseptic dressing of open wound with

appropriate sterilized technique was done in postoperative wards.

- After 2-3 weeks, once the wound is clean and covered with healthy granulation tissue plastic surgeon opinion was taken and treated accordingly.
- Suture removal was done on 11th postoperative day.
- The fracture union status in all the treated cases with monorail fixator on follow up were evaluated on the basis of radiological union scale in tibial fracture score (RUST).
- After which the fixator is removed and patient's limb were immobilized with PTB cast for another 3-4 week.

Radiographic union scale in tibial fracture (RUST),[41]

Score per cortex	Callus	Fracture Line
1	Absent	Visible
2	Present	Visible
3	Present	Invisible

Follow up

- The final functional outcome was evaluated using the modified 'Johner and Wruhs' criteria with modification' to favour life style needs for an Indian patient.
- Patients were followed up periodically at 4 weeks, 8 weeks, 12 weeks, 6 months, 9 months and may be in between if required. The complaints were noted, clinical and radiological analysis had been done.

Assessment of the patients were done, for pain, deformity, shortening, range of motion of knee, ankle, and radiological union have been evaluated.

- Pain was noted as none, occasional, moderate and severe.
- Deformity was noted as none, anteversion-recurvatum, varus-valgus and rotation deformity in degrees.
- Shortening was noted in the form of measurement

and was noted in cm or was noted as nil if absent.

- Range of motion of knee, ankle and subtalar joints was noted in percentage. 100% being normal, more than 80% for knee, more than 75% for ankle and more than 50% for subtalar joint was considered as good.
- Radiological assessment is done on the basis of whether there is callus, or union or if fracture is consolidated.
- Radiological union is noted as consolidated for excellent and good results. Union for fair results and not consolidated for poor results.
- Angular alignment (varus-valgus, anterior and posterior angulation) was assessed radiologically. Varus-valgus was determined by measuring the angle between the line drawn perpendicular to bisecting the tibial plateau and proximal medullary canal with the line bisecting the distal medullary canal and tibial plafond.
- Anteroposterior alignment was determined by measuring the angle between the lines parallel to the proximal fragment and distal fragment on lateral radiographs.
- Rotations were assessed clinically.
- Malunion was considered when varus-valgus angulation was more than 5^{o}, anterior-posterior was more than 10^{o}, internal and external rotations of more than 10^{o} and shortening of more than 10 mm.

Gait was assessed whether normal or associated with a limp.

- In this study fracture, union was considered when patient was weight bearing without pain, fracture site was not tender on palpation, radiograph showed osseous union in antero-posterior and lateral views after removal of fixator.

Modified Johner and Wruh's criteria,[42]

Excellent – no non-union, no infections, no deformity, no shortening, no pain, full range of ankle and knee movements, no neurological deficit and normal gait

Good - no non-union, mild infections, mild deformity, <10mm shortening, occasional pain, range of ankle (>75%) and knee (>80%) movements, no neurological deficit and normal gait.
Fair - no non-union, moderate infections, moderate deformity, shortening 10 to 20mm, moderate pain, range of ankle (>50%) and knee movements (>75%), no neurological deficit and mild limp.
Poor- non-union, deep infections, significant deformity, >20mm shortening, severe pain, range of ankle (<50%) and knee (<75%) movements, neurological deficit and significant limp.

Surgical technique

- Position the patient - The patient was positioned supine with both lower limb in extension on a radiolucent table.
- The C Arm image intensifier on same side of fractured limb and screen was in front of operating surgeon.
- The pneumatic tourniquet was applied above knee position.
- Reduce the fracture- A fracture reduction was performed under supervision or image intensifier guidance according to the wound condition. The reduction was temporarily fixed with reduction forceps.

Application of LRS

After preparation of the part, three Schanz pins were introduced in to proximal fragment of fractured tibia anteromedially. This instrumentation has to be applied only at compressive force side, that is medially or anteromedially to nullify the compressive force of the muscles which are present at posterolaterally which is the side of tensile force.

The insertion of Schanz pins should be done in the following manner:

These three pins were fixed to proximal clamp of LRS. We had to take the measurements of the distal fragment for application of Schanz pins depending upon the length of distal fragment. If

distal fragment was two-thirds of tibia, 2 clamps and 6 Schanz pins were used. For one-third, 1 clamp and 3 Schanz pins were used.

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 4.5 mm drill bit.
c) Remove the drill sleeve.

d) Insert the depth gauge probe through the probe 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 into 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 onto 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.

j) To give more stability to distal fragment as it is mobile, after the application this has to be fixed with nuts situated at posterior aspect of railing with the help of spanner.
k) The compression distraction unit has to be fixed in between distal clamp of proximal segment and distal first clamp of distal fragment.
l) The fixator was placed in neutralization mode in case of comminuted and butterfly fragment fractures. Compression mode in case of transverse, oblique and segmental fracture as to narrow fracture gap and improve stability.
m) Application of fixator should be in such a way that

it should be away from the site of wound. If a soft tissue coverage procedure is required later on, then railing application should be such as to leave enough area for the soft tissue procedure intended.

Soft tissue procedure:

Relaxing skin incisions were placed around the pin tracts to avoid skin compression, bone was covered with overlying muscles, skin approximated with stay sutures. The foot and ankle were manipulated at the end of the procedure to ensure absence of musculotendinous tethering by half pins.

Statistical Analysis

All data were entered in Excel 2010 and statistical analysis was performed using the statistical software SPSS 25.0.Quantitative data were expressed as mean values (with standard deviations) and categorical data were expressed as frequency (with percentages)