MATERIAL AND METHOD
MATERIAL AND METHOD

The clinical material for the study comprised of patients selected out of the patients attending the Orthopaedic services at M L B. Medical College & Affiliated Hospital, Jhansi (U. P.) during the period of March 1991 and September 1992. The cases were selected on the preformed criteria as under and A O. tubular external fixator was applied in selective cases of fractures of tibia (Twelve cases) and fractures of femur (Four Cases).

A O. tubular external fixator was applied after through clinical, radiological and relevant haematological examination.

Criteria for selection of patients:

Patients selected for the study were those having the following
1. Simple unstable fractures of long bones
2. Fractures of long bones with extensive soft tissue damage
3. Multiple closed fractures in poly traumatized patients
4. Ipsilateral tibial and femoral fractures not suitable for open reduction and internal fixation, to allow early Knee function.
5. Severe type II Open fractures of long bones.
6. Fractures of long bone with significant bone loss or in paired bones of an extremity in which maintenance of equal length of the paired bones is important
7. Infected old and ununited fractures

Muller's grading for open fractures

Type I. Fractures were compound from within by sharp bone fragments with minimum soft tissue damage. BASICALLY THESE FRACTURES CAN BE LOOKED UPON AND TREATED AS CLOSED ONE

Type II. Fractures were compound, the skin is disrupted and crushed from without with moderate damage to the skin, subcutaneous tissue and muscle

Type III. These were compounded from without, with extensive skin, subcutaneous tissue and muscle necrosis. They were often associated with injury to nerves and vessels.

A.O. Tubular External fixator

The external fixators used in this clinical study have been newly developed A O (ASIF) "Tubular" external fixation system with its four basic building blocks offering
1. Rigid fixation
2. Versatile frame configurations
3. Access to soft tissues.
4. Fast; easy application and removal (Simplicity is the rule of the game)
FIGURE - IMPLANTS

1. 4.5 MM SCHANZ SCREW
2. CAN CELLOUS FRONT-THREADED PIN
3. 4.5 MM CENTRALLY THREADED

FIGURE - INSTRUMENTATION & FRAME COMPONENTS

1. TRIPLE- TROCAR SET
2. HAND DRILL & KEY WITH EXTRA LONG DRILL BIT 4.5 MM AND 3.5 MM
3. TUBULAR RODS
4. EXTRALONG 4.5 MM TAP
5. ADJUSTABLE CLAMP AND TWIN ADJUSTABLE CLAMPS
6. COMPRESSION-DISTRACTION DEVICE
7. BOXSPANNER 11 MM SPANNER 11 MM AND 10-11 MM
8. UNIVERSAL CHUCK WITH T-HANDLE.
9. CONNECTING CLAMP AND BAR.
FIGURE SHOWING SELF DESIGNED MODIFIED "VERSATILE COMPRESSION - DISTRACTION" DEVICE.

DIFFERENT COMPONENTS OF VCD-DEVICE. VCD-DEVICE READY FOR USE

ROTATION OF CIRCULAR COMPONENTS ON THE THREADED ROD, THAT LYING TOWARDS FREE END DISTRACTING AND THE ONE TOWARDS THE BENT END COMPRESSING THE BONE. THE DETACHABLE CLAMPS FIXED WITH PINS ON CENTRAL PIECE AND THE BENT BAR.
Basic Building blocks are implants and frame components.
Implants or First building block is

(1) **4.5 mm Schanz screw**

18mm thread length with overall lengths of 100 mm 200mm,
Blunt tip (Non-self tapping) reduces the possibility of Neuro vascular injury
Enhances rigidity of the frame by placing a larger diameter (4.5mm) shaft at near the cortex where bending forces are the highest
39% increase in bending stiffness compared to 5.0 mm schanz screw with threads in both cortices (R frigg MEM Institute for Bio Mechanics, Bern, July 1984)

(2) **4.5 mm Steinmann pin**

II Second building block is 4.5 mm Steinmann pin which comes in lengths ranging from 150–250 mm or 4.5 steinmann pin with a central 5-mm thread of 150-200 mm length

(3) **6.5 mm Cancellous Front Threaded Pin Thread length 16-50mm**
(Third building block)

**Frame components**

(A) **Basic frame components**

(I) The fourth building block is Adjustable clamp, which makes it possible to connect the other three components. The adjustability of the clamp allows for correction in all planes and prestressing of schanz screws

(ii) The fifth building block is 11mm stainless steel tube

Light weight
Sufficiently rigid to allow early weight-bearing
Variety of lengths 100mm - 650 mm
Roughly two and a half times as rigid as the earlier threaded bar

(B) **Supplementary frame components**

I. Connecting clamp which connects tubular rods to each other with the help of connecting rods to construct different type frame configuration.

II. Connecting Bar 50mm x 8' length

III. Twin adjustable clamp- straight and curved
Instrumentation

I Triple Trocar set: It consists of Trocar, 3.5 mm dia, drill sleeve 5 O/3.5 dia and drill sleeve, 6 O/5 Omm dia
II) drill bit 3.5 mm and 4.5mm, extra long drill bits
III) Universal chuck with T-Handle
IV) Compression - Distraction Device
V) Self design modified versatile compression distraction device of long bone
VI) Spanner 11 mm
VIII) Tap 4.5mm

MANAGEMENT OF PATIENT

1. First aid management.

The management of patient was started as soon as the patient was brought in the emergency ward of this hospital. The patient was hospitalized immediately and through and precise general, local and systemic examination was done. The first aid treatment included correction of dehydration by intravenous infusions and blood (if needed); and injecting tetanus antitoxin, tetanus toxoid, antibiotics, analgesics, sedatives and serum anti-gas gangrene, where required. The wound was cleaned with the help of hydrogen peroxide, and normal saline, dressed and POP slab applied. At the same time any other injury was looked upon and treated accordingly. The patient was subjected for radiological examination of the injured limb as well as other parts where injuries were suspected.

2. Primary definitive treatment

All the patients were kept nil orally for through irrigation and debridement of wound along with application of external fixator and reduction under general/spinal anaesthesia at the earliest possible time, depending upon the availability of operation theatre and anaesthesia and the general condition of the patient and his feeding history.

(a) Surgical toilet and debridement for open fractures--

After giving a general or spinal anaesthesia, patients wounds were subjected to thorough washing, first with soap and autoclaved water and then with hydrogen peroxide and copious amount of noraml saline. Wound was thus cleared of all debris, dirt, blood clots and any other foreign material, thus prepared for the purpose of wound debridement.

Now part was painted and draped and thorough debridement of the wound done. Skin margins were freshened in lacerated wounds; muscles not bleeding and not contracting to stimuli removed, crushed subcutaneous tissue and small loose pieces of bone and foreign material in the tissue removed as far as possible. Whenever necessary, skin incision was extended to facilitate the debridement process. Haemostasis was achieved and bone was covered by soft tissue as far as possible and stay sutures applied. Where wounds were small and clear, they were closed by primary suturing after thorough debridement.
Any associated soft tissue and bone injury, when present, was taken care of at the same time

(b) Application of external fixator.
Operative procedure
After the patient was anaesthetised the skin was prepared and cleaned and then the wound was thoroughly cleaned. The part was then draped, adequate debridement was then done if needed. The near anatomical reduction was then achieved and the limb held by the assistant.

At least two to four schanz screws/Steinmann pins were placed in each major fragment in one or two plane according to the type of fracture and fractured bone. The technique recommended by Hierholzzer et al (1985) was followed. The "safe corridor" described by Behrens and Searls (1986) was used for Schanz screws or steinmann's pin insertion. The distance between the two screws in each fragment (Pin Pitch) was at least 3.5 CM. The frame was constructed according to need of fixation.
Schanz Screw Insertion Technique.

Step 1: Assembled the triple Trocar and penetrate the soft tissue through a stab incision on to the bone surface.

Step 2: Removed the Trocar and drill through both cortices using an extra long 3.5 mm drill bit.

Step 3: Removed the 3.5 mm drill sleeve through the remaining 6.0/5.0 mm drill sleeve over drill the near cortex using an extra long 4.5 mm drill. Tapped cortex by 4.5 mm Tap for non self-tapping schanz screw.

Step 4: Using the universal chuck with T-Handle; inserted the 4.5mm schanz screw into the bone through the drill sleeve.

Step 5: Removed the drill sleeve and attached the adjustable clamp.
4.5mm Steinmann Pin Insertion Technique.

**Step 1** Assembled the triple trocar and penetrated the soft tissue through a stab incision on to the bone surface.

**Step 2** Remove trocar and 3.5mm drilled sleeve, drill through both cortices with 4.5mm drill bit.

**Step 3** Inserted Steinmann pin with universal chuck with T-handle through 6.0/5.0mm drill sleeve.

**Step 4** Removed the drill sleeve and attached the adjustable clamp.
Single Tube Unilateral Frame

**Step 1.** Through a small stab incision, insert one Schanz screw into one main fragment, along the anterior crest of the tibia and as close to the joint as possible.

**Step 2.** Over a proper tube four adjustable clamps mount. Connect the end clamp to the Schanz screw inserted in Step 1.

**Step 3.** Insert the second Schanz screw, through the adjustable clamp, into the other main fragment as near to the joint as possible. Now reduction should be completed at this time. Tightening of the most proximal and distal clamps. Before insertion of the remaining Schanz screws, a proper alignment rotational as

**Step 4.** Through the remaining to clamps, insert the inner to Schanz screws in the same plane for the later dynamization plan.

**Step 5.** Individually preload the Schanz screws. Within the same fragment bend the Schanz screws towards each other and tighten the nuts and release any skin tension.
Double Tube unilateral frame.

**Step 1** Through a small stab incision insert a schanz screw into one main fragment as close to joint as possible along the anterior crest of the tibia/or postero lateral side fenur 2.1.5 mm schanz screw.

**Step 2** Select two tubes of appropriate length as and place four to six adjustable clamp on each tube to the inserted schanz screw in step. The clamps of the upper tube should insert on the clamps of the lower tube.

**Step 3.** Insert the second schanz screw through the corresponding adjustable clamp and into the other main fragment as near to the joint as possible. With slight distraction of the fracture fragments, manual reduction should be completed at this time. Tightening of the most proximal and distal clamps to the tubes will secure the reduction. Particular attention must be given to proper axial and rotational alignement of the main fracture fragments prior to insertion of the remaining schanz screws.

**Step 4.** Through the remaining clamps insert the inner two schanz screws as shown for later dynamization, it is essential to have the schanz in the same plane.

**Step 5.** To individually preload the schanz screw, loosen the schanz screw and tube nuts. Within the same fragment pend the schanz screws towards each other and retighten the nuts. Cut the schanz screws above the clamps if needed and release any skin tension around the schanz screws.

The uninjured limit may serve as a reference.
**Construction of Bilateral frame**

**Step 1.** Choose the point of insertion of steinmann pin. On the lateral side just above the ankle and anterior to the fibula. Make a stab incision and insert a steinmann pin at $90^\circ$ to long axis and parallel to the axis of the ankle joint.

**Step 2.** At the Proximal tibia, insert a second steinmann pin. Before the pin track is drilled, an attempt should be made to realign the lag and reduce the fracture as much possible.

**Step 3.** Now choose the tube of proper length with required number of clamp. Applied both tubes bilaterally to the steinmann pin by very end clamps and tighten the nuts.

**Step 4.** The fracture is now sufficiently stabilized to permit further insertion of the remaining pins through clamp with help of aiming device, the distance between pins and area of injury is determined by the soft tissue damage.

**Step 5.** Compression or distraction given at the fracture site if needed by compression distraction device. To increase the stability, preloading of each steinmann pins is done.
Construction of Delta frame

**Step 1.** Construct a single tube unilateral frame along the anterior crest of the tibia/posterior lateral surface of the thigh.

To improve rotational stability and significantly increase rigidity.

**Step 2.** Along the medial aspect of the tibia/antero-lateral aspect of the femur construct a second single tube unilateral frame at a 60°-90° angle to the first frame. Preload is applied to the Schanz screws of each frame.

**Step 3.** To further improve rotational stability the two frames are connected using either additional adjustable clamps or connecting clamp and 5.0mm connecting bars or Steinmann pins.

Rigidity of Frame.

To increase rigidity of frame:
- Increase the number of Schanz screws.
- Increase the distance between the Schanz screw.

- Reduce the distance between tube and bone.
- Add a second tube to the frame.
- Convert unilateral frame into delta frame.
- Pre-loading tension to the Schanz screws.

To decrease rigidity:
Decrease the number of Schanz screws
Increase the distance between the tube and bone
Remove the second tube
Remove the second frame.

**Preloading of Schanz Screws**

Applying a preloading tension to the Schanz screws will minimize micromovements between the cortex and Schanz screws.

Bone resorption around the screws
Loosening of the Schanz screws
Pin tract infections

**Method:**
To individually preload the Schanz screw, loosen the Schanz screw and tube nuts. Within the same fragment bend the Schanz screws towards each other and retighten the nuts.
Method of Dynamization of Frame

Dynamization: Dynamization allows transfer of load to the fracture site, while maintaining axial alignment and controlling rotation. Dynamization is desirable to further stimulate healing at the fracture site after callus formation has begun.

Step 1. The two tubes must be parallel in all planes. This is accomplished by having the clamps of the upper tube in contact with the corresponding clamps of the lower tube.

Step 2. Loosen the tube nuts of all clamps (A1 and A2) on the lower tube that are distal to the fracture. Then, loosen the tube nuts of all clamps (B1 and B2) on the upper tube that are proximal to the fracture.

Step 3. The frame will now permit axial loading of the callus and maintain rotational stability.

Step 4. For optimal gliding, individually loosen and immediately retighten the Schanz screw nuts of the clamps outlined above.
Important Precautions During Application Of Fixator.

1) A hand drill should always be used when inserting the steinmann pin or schanz screw. A power drill may produce thermal necrosis.

2) Always use a guide for pin insertion.

3) Align the fracture before pin insertion.

4) Necrosis of soft tissue around the pin can be reduced by releasing all tension with a scalpel blade.

5) Excessive soft tissue motion around the pin can be reduced (but not eliminated) by wrapping the pin group with a bulky soft wad; filling the space between the open gripping clamp and the skin.

6) Early cancellous bone grafting to prevent delayed union.
7) Allow space for swelling to prevent pressure necrosis which occurs due to persistent contact of frame with the patient's skin.

8) Always insert pin in the "safe corridors".

9) Motion of the pins within the bone can be diminished by employing only thread pin.

10) Daily pin care routine - daily cleaning of pin skin interface by hydrogen peroxide, saline, alcohol or soap water.

11) Early removal of the septic pins and avoidance of dense cortical bony ridge such as anterior tibial crest are must to prevent chronic pinhole osteomyelitis which forms ring sequestrum.

**After Treatment.**

Patient was allowed crutch walking without any weight bearing when the pain subsided and knee and ankle movements were encouraged the same day. The wound was dressed daily and time of healing of the wound noted. Xrays were taken at regular intervals to check for the evidence of callus formation. When the wound had healed, clinically there was no abnormal mobility and radiologically there was callus formation, encourage partial to full weight bearing gradually with/without dynamization of frame.

The patient were then followed at regular intervals of weeks and the state of the wound, any complication, any secondary procedure, and condition of the bone clinically as well as radiologically were recorded.

When there was evidence of clinical and radiological union; patient's fixator was removed without any anaesthesia and sedation in O.P.D. Clinical and radiological examination was done and patient was sent back with continuance of weight bearing and called for regular FOLLOW UP TO see for progress.

- None of the cases needed reapplication of fixator.
FIGURE SHOWING LEG WITH PART PAINTED AND DRAPED PER OPERATIVELY.

FIGURE SHOWING DRILL THE HOLE WITH THE HELP OF HAND DRILL AND TRIPLE TROCAR SET.
FIGURE SHOWING SCREW INSERTION WITH UNIVERSAL CHUCK WITH T-HANDLE IN PRE-DRILLED HOLE.

FIGURE SHOWING SCHANZ SCREWS INSERTED PROXIMAL AND DISTAL TO FRACTURE SITE.
FIGURE SHOWING EXTERNAL FIXATOR IN ANTERIOR PLANE DURING FIXATION, AFTER REDUCTION

FIGURE SHOWING CONSTRUCTION OF THE DELTA FRAME IN CASE OF FRACTURE TIBIA.