

DELAYED AND NON UNION OF LONG BONE FRACTURES – CASE SERIES

Prof. (Dr.) M. Shantharam Shetty M.S.(Orth), FRCS, FACS
Pro Chancellor, Nitte University

Abstract

How the saga of non union has changed in the last 50 years from the Classification to the Causes of delayed and non union to Diagnosis and even the Management is amazing.

The biotechnological pursuits specially over the last 10 years has equipped the surgeon with better understanding of this common entity. This cases series depicts the challenges we meet in different types of Non Union ranging from Avascular to Vascular infected to non infected and gap to complex non unions of long bones. The 11 cases depicted here narrates how to face these challenges and there is a message in each case.

Definition: Delayed Union

The fracture has not completely healed or failed to unite in the expected time it should have.

However the type of the fracture, the patient and the method of treatment has to be taken into consideration.

Definition: Non-Union

Fracture has failed to unite and is not likely do so without definitive intervention

Different types of non-union



Non-Union

- FDA defines it at a lag of 9 months and the AO at a duration of 8 months. But if there is no visible sign of healing for 3 months on review, it is to be considered as Non Union.
- However, time is non specific since it varies from fracture to fracture, patient to patient

Classification or Types (Webers) ^{9,5}

Vascular

- Hypertrophic
– Elephant boot



hypertrophic/vital



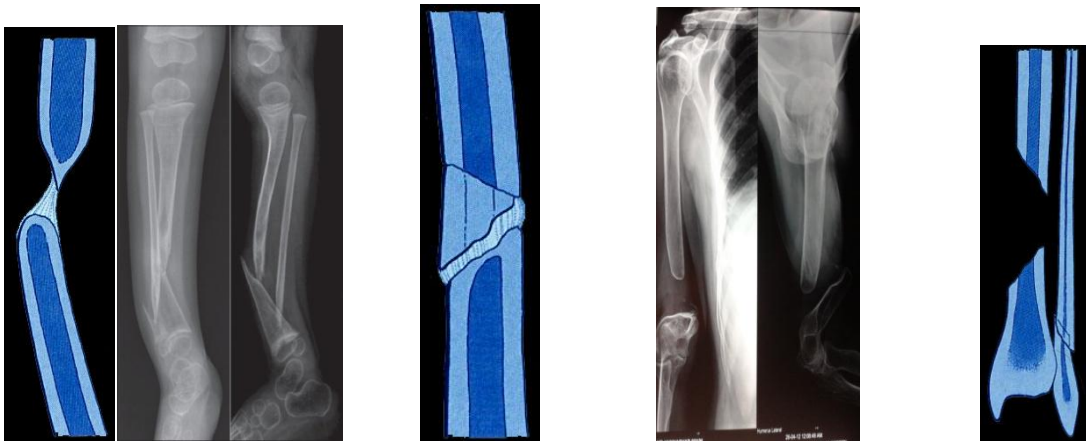
avital?

- Oligotrophic
- Bone scan - vascular

Avascular

Atropic – cold on bone scan

- Wedge
- Gap

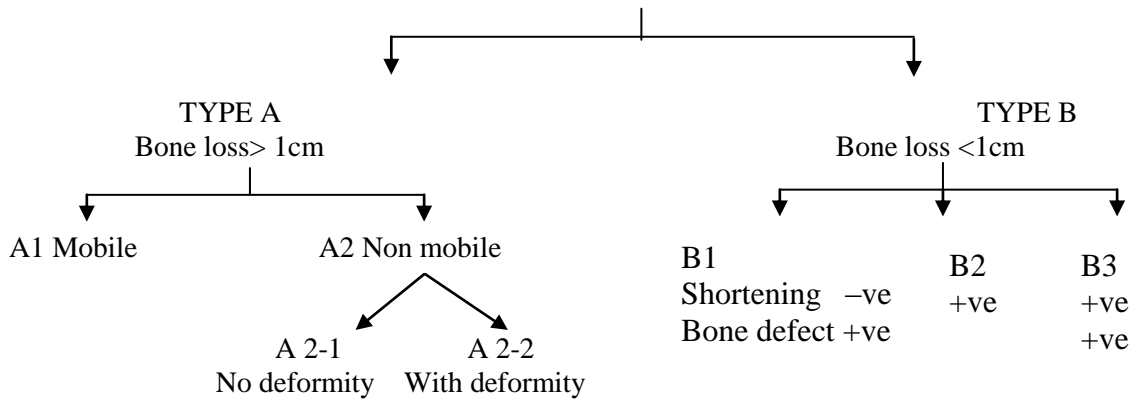


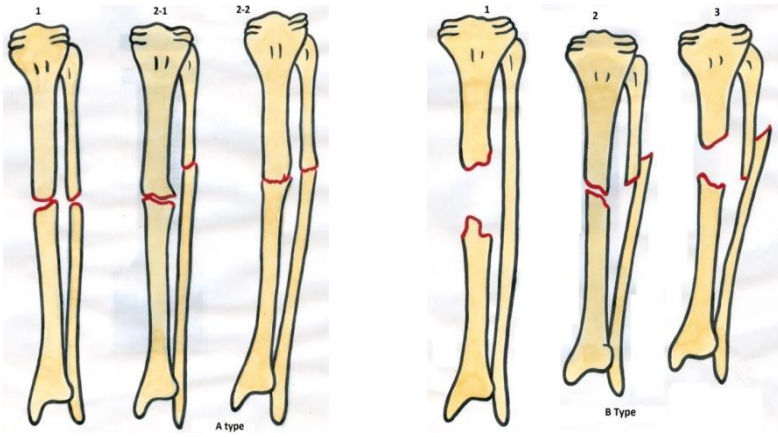
• No callus

necrotic

Defect

PALEY'S CLASSIFICATION⁹





Whatever may be the classification

It is important to differentiate between a cat to a tiger and tiger to a cat for management depends on whether it is vascular or non vascular, infected or aseptic with a gap or a psuedarthrosis

Delayed and Non Union

- Does not differ much - if the process is controlled, delayed can be converted into union and if uncontrolled will go into Non Union



Case No. I: Delayed Union

Example: A Communitated fracture of both lower leg type I open operated within 6 hours of injury with I.L Nailing went into Delayed Union in 3 months. Dynamization with weight bearing done and after 3 months the fractures consolidated. A classified example of delayed union converted into union Fig 1 to 5 by simple dynamization.

Fig 1

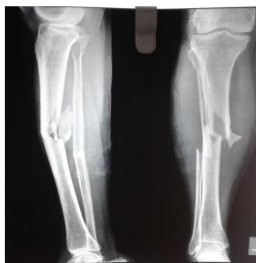


Fig. 2



Fig. 3



3 months



Fig. 4



Fig. 5

- 3 months after dynamisation

Causes of Non Union of long bones are – Systemic / Local

- Systemic causes are⁵
 - Smoking,
 - Alcoholic
 - Diabetes
 - Metabolic disorders
 - Endocrinal
 - NSAIDs

Non Union Local Causes are

- a) Infection
- b) Lack of blood supply
- c) Type of fractures
 - open with extensive soft tissue damage
 - High velocity injuries
 - badly comminuted shattered fractures
- d) Irradiated bone
- e) Improper inadequate fixation
- f) Anatomical location of fractures (Mechanical, biological factor, blood supply etc)

Clinical Diagnosis

Delayed Union

- Pain, tenderness at the fracture site, slight abnormal mobility

Non Union Clinical

- Painless abnormal mobility, there can be deformity, shortening, infection with or without implant in situ
- Always assess the joint stiffness proximal and distal always which will have an important say in the management.

Investigations

- Blood profile – Infection – Diabetes, Metabolic Endocrine.
- Biopsy to rule out pathology if there is doubt of a pathological fracture.

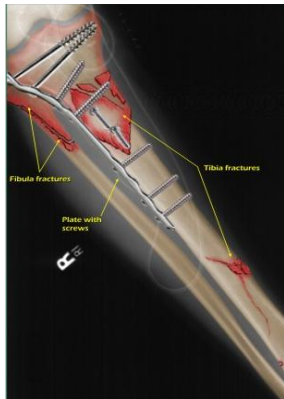
CT and MRI – may be necessary in some cases

A good x-ray

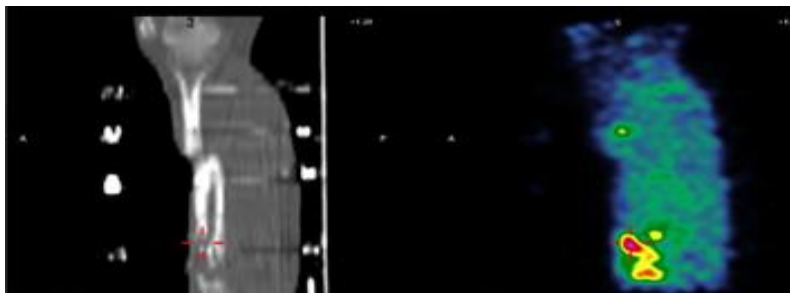
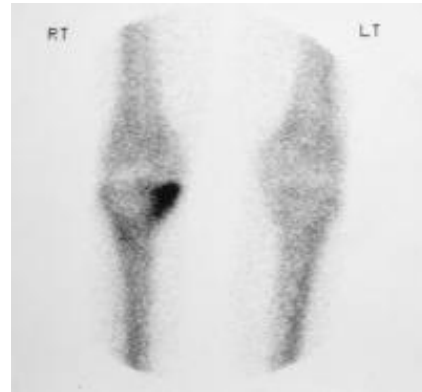
Stress films wherever necessary



Radionuclide Imaging and petscan



$^{99\text{M}}\text{Tc}$
 $^{111}\text{In WBC}$
 ^{67}Ga



PET scan

- Positron emission tomography (PET) scanning with ^{18}F -fluoride ion, which localizes in regions of high osteoblastic activity
- ^{18}F -fluorodeoxyglucose (FDG), an indicator of cellular glucose metabolism, in assessing bone healing

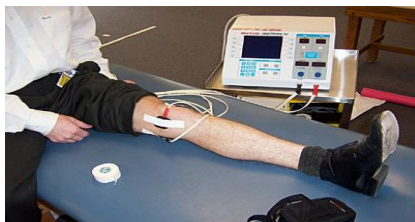
Tackling of Non Union

- Bring about a Mechanical and Biological and osteogenic potentiality at the Non union site to bring about a sound union.

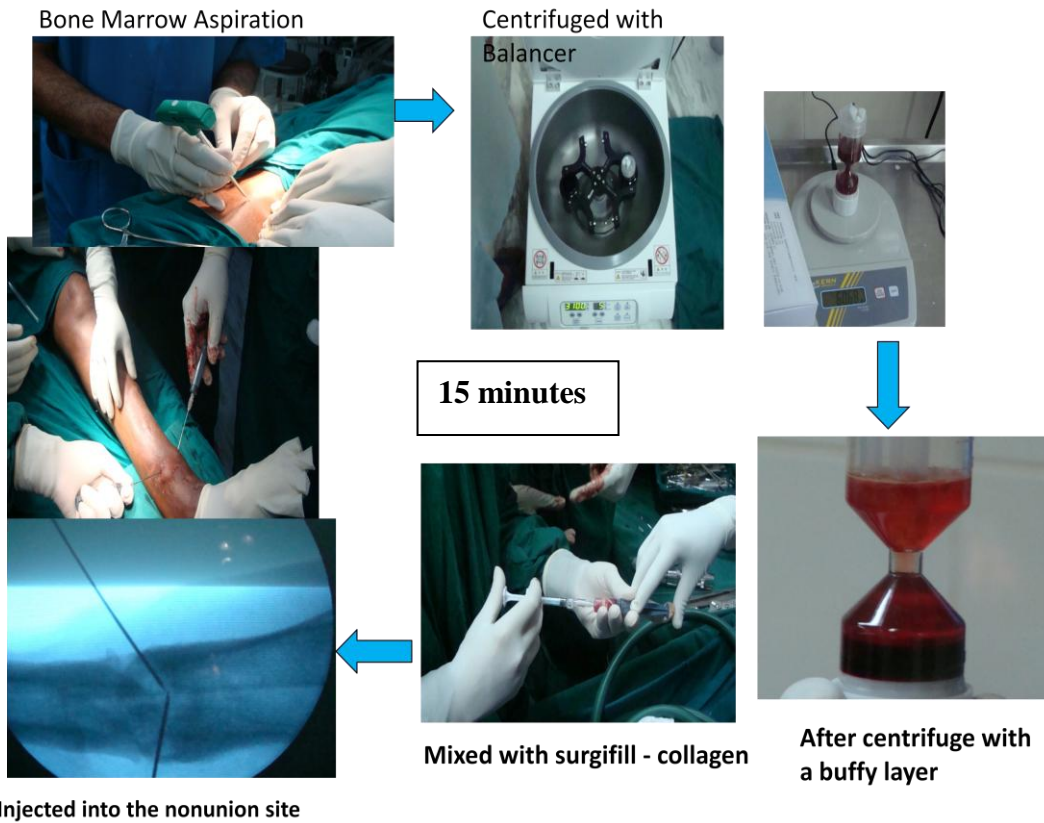
Non operative Methods⁶:

- Electrical stimulation
- Laser therapy
- Ultra sound
- Bone marrow injections
- BMP injections

The first three requires lot of patience both on the part of the surgeon and the patient.



Bone marrow Injections recently have evoked lot of interest around the world and in our own institution with the collaboration from Christ Church University, Canterbury and Christian University, Korea have done some cases specially in delayed and non union and the results are quite encouraging.



**Bone Marrow Aspirate Concentrate (BMAC)
Transplantation for Cartilage and Bone Regeneration**

Separation of bone marrow in to RBC and Plasma by centrifugation 20 ml volume BM+ACD-A solution @ 1:5 volume



SPRP Kit



Centrifugation @ 3200rpm for 5min

Established Non union treated with Ilizarov ring fixtature. End of 4 months still no signs of union. BMAC done at 4 months. The fracture fully consolidated at 7 months.

Case II: Segmental Fracture tibia treated with I.L Nailing. Both the fractures did not unite in 6 months. BMAC done at 6 months. Both the fractures united in 9 months time.



Fig. 1 to 4

Surgical Management and Guidelines

- Proper reduction
 - Angulation
 - Length
 - Rotation
- Bone grafting
 - Yes
 - No
- Stabilization
 - Absolute } - Proper selection of Implants
 - Relative }

Proper Reduction

- Excessive dissection should not be done
- Open the medullary cavity after excising the sclerotic bone
- Fill the gap with bone grafts if necessary
- Stabilize it – preferably
 - plate
 - Nail
 - External fixtures
- Each patient is different and each Non Union is different. Planning is paramount.

Bone grafting and bone substitutes to be used whenever necessary

Case III: This patient aged 35 years presented with a non union of distal end femur with a broken implant. This is a clear example of a non union due to the improper selection of implant. A buttress plate failed and broke. This was replaced with distal femoral plate with autogenous bone graft and the non-union united with a good functional outcome in 6 months' time.

Failure of Implant due to improper selection of implant have added on to the cause of non union



Fig. 1

Message: Proper implant has to be used and bone graft wherever necessary.



Fig 2

Case IV: A fifty year old male presented with a infected non union 4 months after a infected plate was removed with a shortening of 3 cms using a Ilizarov ring fixature with a proximal cortical osteotomy. The limb was lengthened by 2.5 cm and the old infected fracture, united well with good function in 8 months time. Fig 1 to fig. 4.

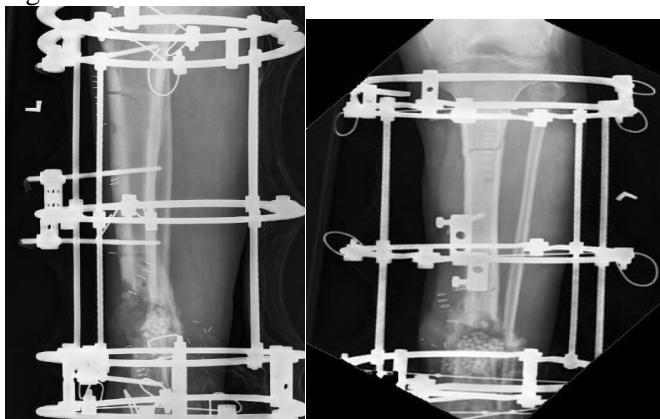
4 months after plate removal, debridement Culture positive – pseudomonas

Fig. 1



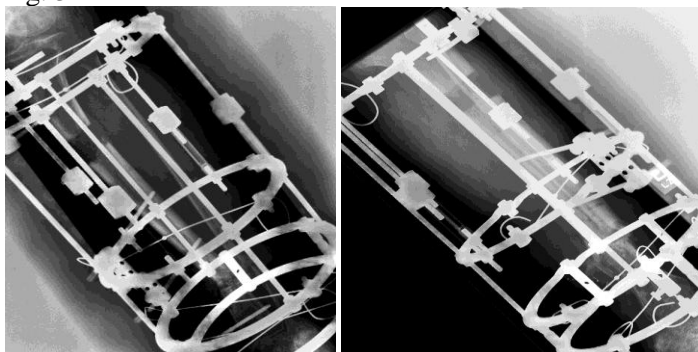
Post debridement - antibiotics beads in situ.

Fig. 2



6 weeks - fragment transport

Fig. 3



Frame removed after 8 months

Fig. 4



Message: Ring fixature is an excellent method in infected and non union with shortening to bring about union of the fracture, control infection and correct the shortening⁷.

Case V: This 20 year old young man presented with a I.M Nail for fracture shaft of femur with a gap of 5 cms. Had also a fracture patella operated with circularage wires. A distal femoral corticotomy and bone transport over the nail was done for this gap non union. In seven months, the regenerate consolidated well and the bone transport over a nail maintains rotation and prevention of angulation and enhances joint mobility.

Distal locking screws removed, corticotomy done and distraction (bottom- upwards) commenced

Fig. 1

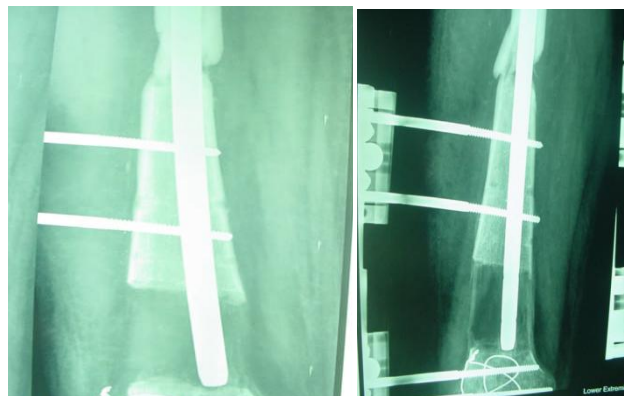


Fig. 2



Corticotomy and transport over nail

Fig. 3



Proximal Docking with regenerate

7 months following corticotomy

Fig. 4



Regenerate consolidated well

After nail removal

Fig. 5



Message: A gap non union can be successfully treated with a corticotomy and bone transport. This case shows how mal-rotation and angulation can be prevented.

Case VI: This 34 year old lady presented with an established non union of fracture neck of femur and a stress film showed a gap non union, head of femur looked vascular.

A tensor fascia muscle pedicle graft was planned with a anterior approach to the hip and the gap filled with pedicle and the fracture fixed with a DHS and a derotation screw with a valgus osteotomy done at the intertrochanteric plane. The figures 1 to 9 show the different steps of surgery and finally 3 years follow up and union of the fracture with good function.

Fig. 1



Fig. 2



Fig 3

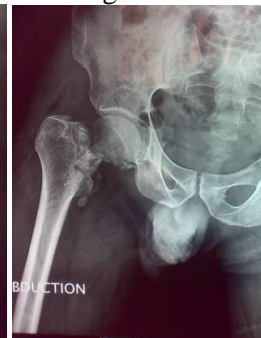


Fig. 4



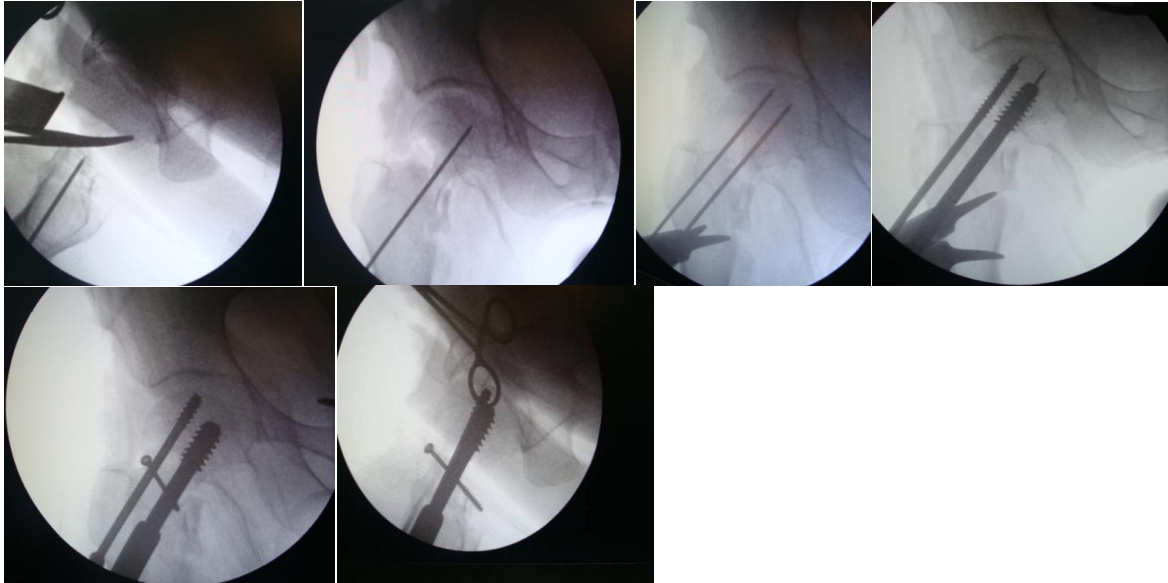
ANTERIOR APPROACH , GAP AT THE FRACTURE SITE

Fig. 5



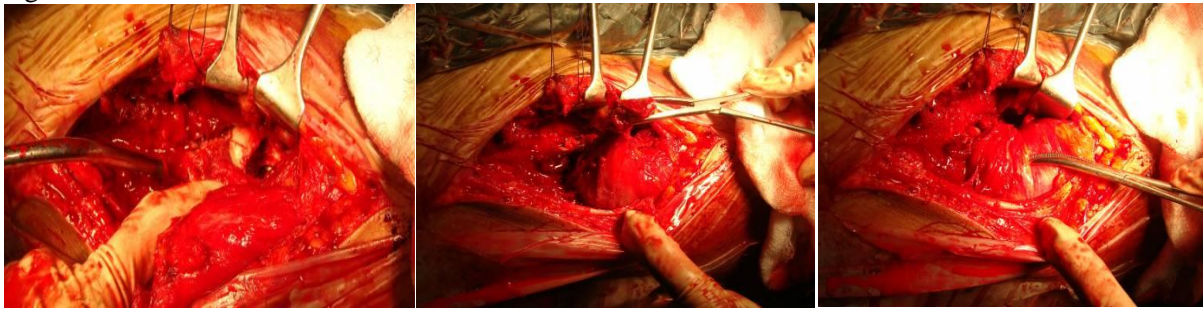
OPEN REDUCTION

Fig. 6



TFL muscle pedicle graft

Fig 7



Immediate Post-op

Fig 8



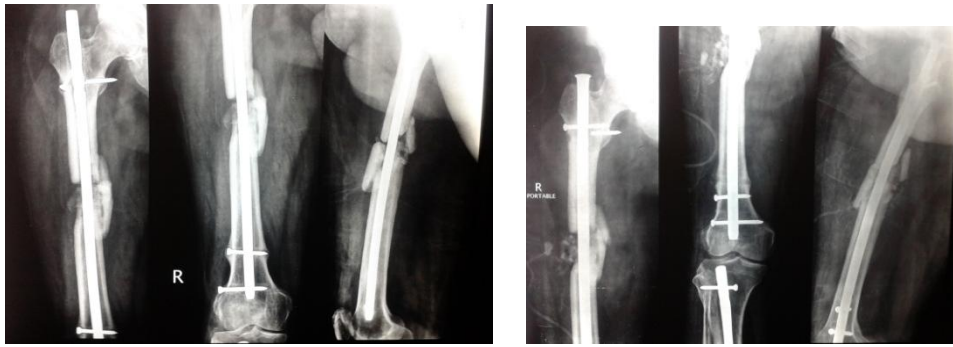
3 years follow-up

Fig 9



Message: A valgus osteotomy with pedicle graft is an excellent method to bring about union in a non union of fracture neck of femur.

Case VII: This 32 year old man, 110 Kg presented after 7 months after this surgery at Middle east with pain and inability to bear weight. Radiologically and clinically it was a non-union, hence autogenous bone grafting was done.



Got back to work & presented after 6 months with this picture...
c/o mild pain but able to carry out most of his activities.



9 months post 2nd surgery
h/o trivial fall, he had a breakage of a I.M Nail.



12 mm Exchange nailing with bone grafting & LCDCP fixation was done and he presented after 10 months with a solid union.



Message and Lessons Learnt:

1. When we exchange the nail, for a non union or delayed union of long bone, ream it, preferably 1.5mm larger than the desired nail to be inserted ¹¹.
2. Graft it fully all around with corticocancellous grafts and shingling if need be.
3. Why the nail broke was as it was a thinner nail & rotational instability & graft got resorbed over time.
4. The rotational instability was corrected by incorporating a LCDCP.
5. Mechanical and biological stability are the key factors in bringing about union in a non union of fractured bones.

Infected Non Union ⁸ is a different ball game , Rules to be followed are:

- Totally eradicate infection by proper debridement, of infected and devitalized tissues, removal of implants
- Temporary stabilization by External fixator – local antibiotics delivery antibiotic beads, antibiotic coated nails etc.
- Secondary stabilization with bone grafting

Infected Nonunion

- Difficult challenge.
- Surgical intervention depends on condition of the patient, Infecting organism or organisms, local conditions at nonunion site.

Aim

Infective Nonunion → Aseptic union

Epidemiology

Most common organisms

- Staphylococcus aureus
 - Group A strep
 - Enterococcus
- Recent rise in
 - Staphylococcus epidermidis
 - Methicillin resistant Staphylococcus

Treatment depends on

- Identification of correct organism
- Pain
- Presence of Hardware / Instability
- Deformity
- Loss of bone
- Soft tissue damage

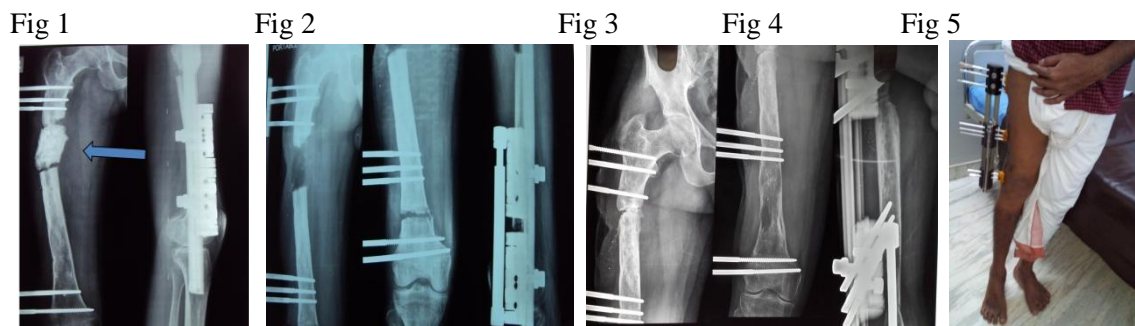
Staged Fixation

- Assist in creating an optimal environment for infection control,
- placement of an antibiotic bead pouch with antibiotic-impregnated bone substitute or bone cement is beneficial.
- The wound is clean and dry and laboratory test (ESR and the CRP level) results have returned to normal (typically between 6 and 12 weeks postoperatively), definitive fixation with compression plating and bone grafting can be done.

Bone Loss

- Masquelet technique
- Ilizarov
- Orthofix

Case VIII: Masquelet technique



This patient came with a infected non union of upper $\frac{1}{3}$ shaft of femur. A thorough debridement and excision of infected, avascular bone was done resulting in a gap non union of 4 cm. By Masquelet technique, a bone cement spacer with a external fixator was undertaken. After 2 months, the spacer was removed and distal femur osteotomy and bone transport was done and in 10 months time the gap was completely filled and the distraction osteogenesis regenerate was complete.

Case IX:

Treatment of infected non union is complex

- Treatment begins with good cultures to correctly identify organism
 - Off antibiotics
- Thorough debridement
- Appropriate antibiotics
- Appropriate Stabilization
- Delayed definitive reconstruction when infection eradicated
- If one cannot reconstruct and bring about union of the fracture, arthrodesis or replacement is the best choice.
- As a salvage procedure

A senior executive of oil Refineries in Mangalore met with a Road Traffic accident on 28-1-2008 When a sugarcane truck hit his car and the sugarcane sharp spikes almost shaved off his (L) u.limb.

This was the picture before debridement and he had a contused chest as well.

He had a radial nerve injury, distal vascularity was intact

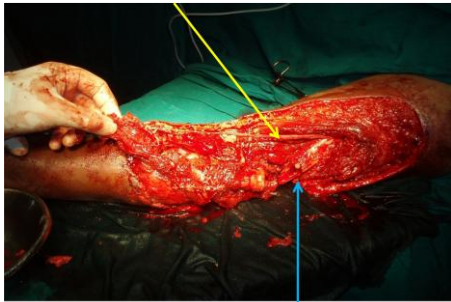
No other injury



- Initially he was taken to a local hospital where initial debridement was done and POP slab was given
- He was shifted to the hospital same day and a thorough debridement was done within 12 hours



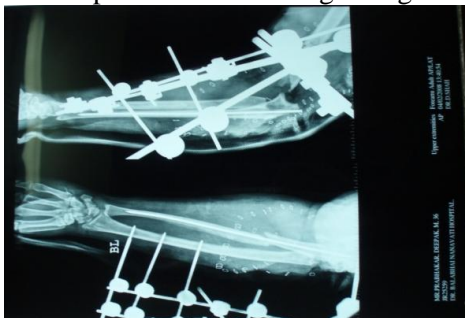
After a thorough debridement, you see the fracture ends, the radial nerve was beyond tagging as part of it was shaved off.



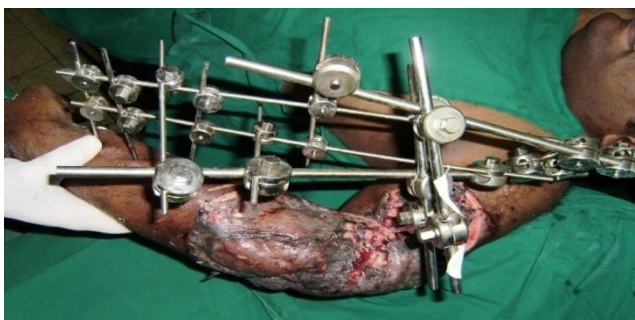
Initial X-ray shattered elbow, fracture of ulna, and segmental fracture humerus



After debridement ulnar fracture was fixed with a intramedullary nail and an external fixator was put in. 2. split thickness skin grafting was done on the 5th day



On the 14th day and split thickness grafting was done



- Patient discharged on 1st March and readmitted on 2nd April
- Pin track infection and Ex-fix was loose
- Ex fix was removed and functional brace with a elbow hinge was given

On 2nd April he had loosening of the pin track and persistent infection so the ex-fix was removed and he was put on a functional brace



He was keen to join his office

In 2 months of functional bracing this was the picture radiologically with a non union.



- For the Radial Nerve Palsy, since he had no stiffness of the wrist MP & IP joints, modified Jones transfer was done on 24th Dec 2009
- Continuously on Physiotherapy.
- Regained good function of hand with functional brace
- In April 2010, an arthrodesis of the elbow was done. He is driving his car and playing golf now.

Lessons Learnt

- Initial debridement and primary cover and ex-fix is vital for open fractures to heal and later functional reconstruction.
- Jones transfer is an excellent tendon transfer for Radial nerve palsy.
- Sustained efforts and proper planning can give an excellent results. Arthrodesis of the left elbow is a good procedure and the patient can do most of the work with a good functional hand.
- A staged procedure from day 1 to different stages with an aim to good functional outcome is necessary in a non union of this nature.

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