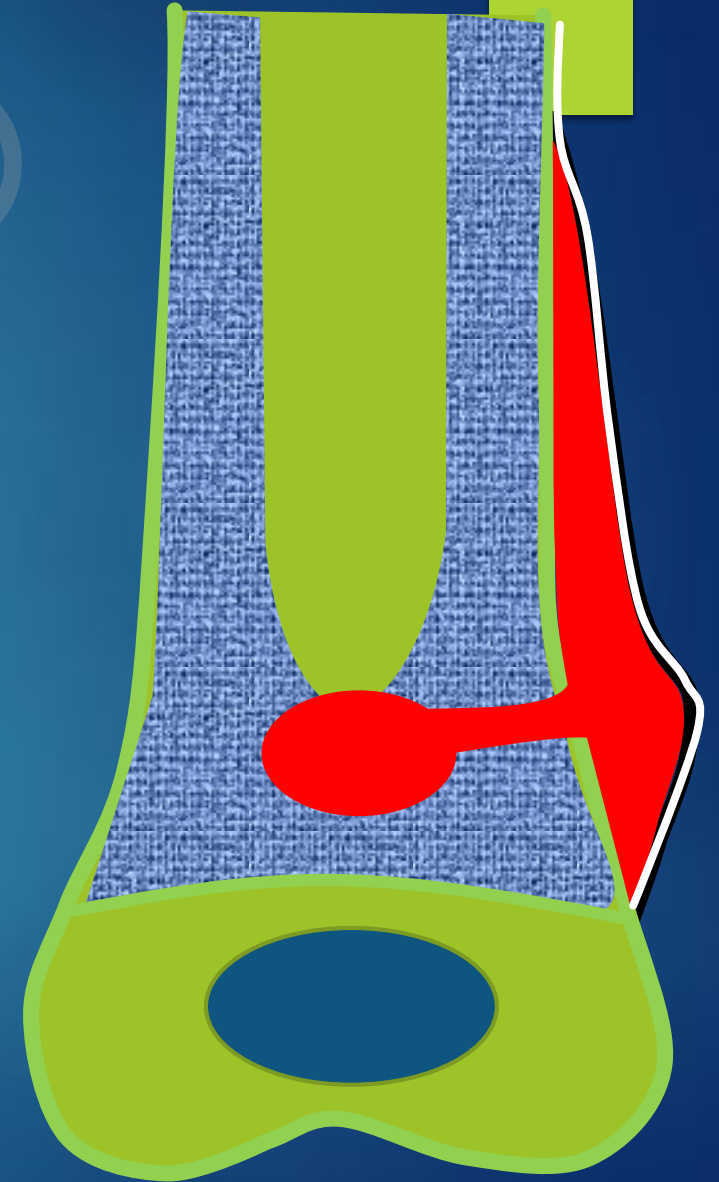


Pediatric Musculoskeletal Infections: 1

Shalin Shah
MS Ortho; DNB Ortho;
Fellowship in Paediatric Orthopaedics



Orthokids A'bad



BJ Wadia,
Mumbai



Pediatric Musculoskeletal infections

▶ Acute and Chronic osteomyelitis

▶ Septic Arthritis and its sequelae

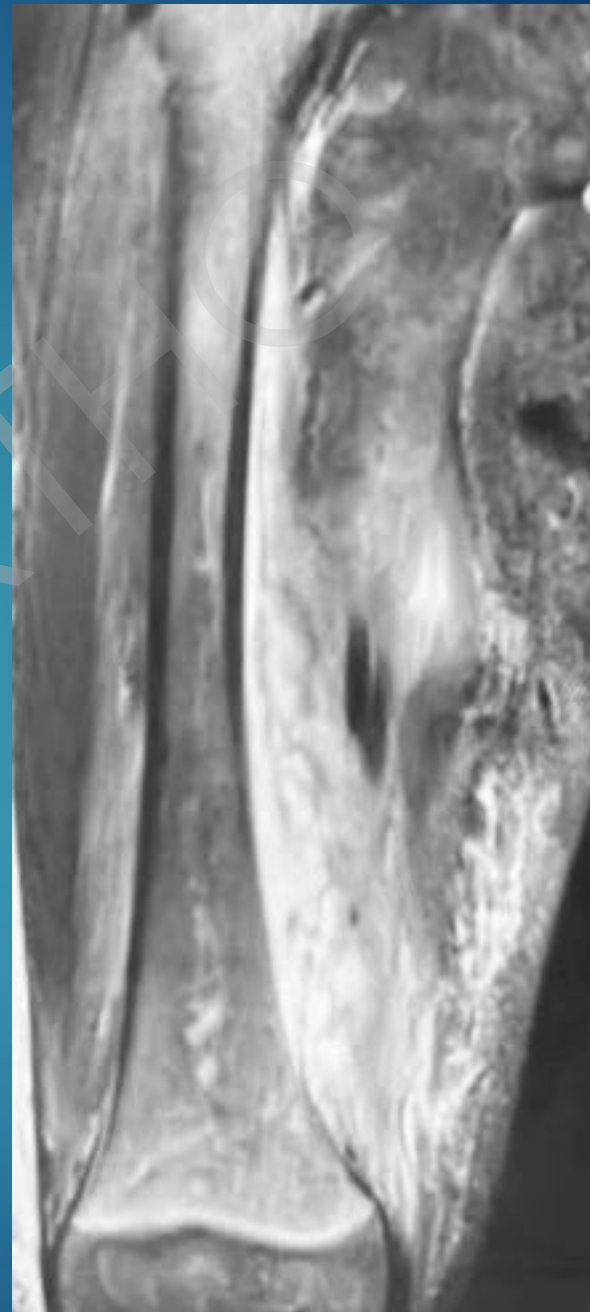


Osteomyelitis

- ▶ Infection of the bone and the marrow
- ▶ 5% of pediatric operative orthopaedic cases
- ▶ 75% as part of systemic sepsis
- ▶ Need a multidisciplinary approach:
Orthopaedic Surgeon; Infectious disease specialist;
Plastic surgeon; Nutrition; Nursing Care

Classification: Temporal

- ▶ Acute
- ▶ Subacute
- ▶ Chronic



Classification: Temporal

- ▶ Acute
- ▶ Subacute
- ▶ Chronic



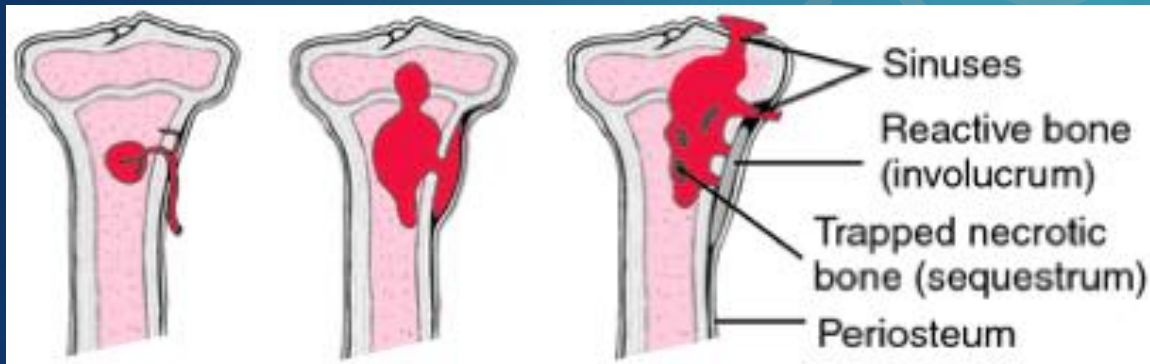
Classification: Temporal

- ▶ Acute
- ▶ Subacute
- ▶ Chronic



Classification: Source

► Hematogenous

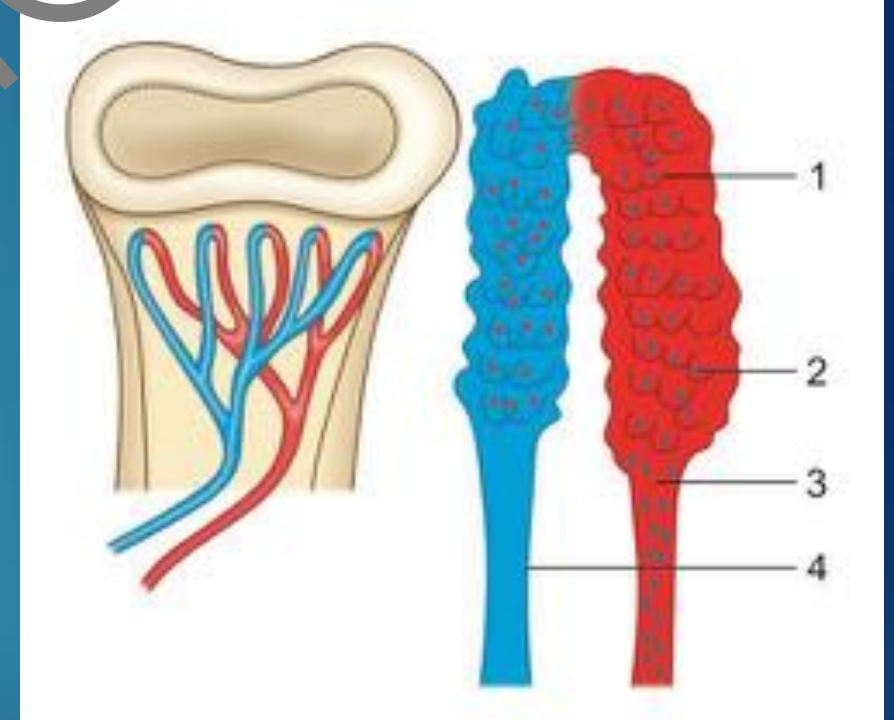
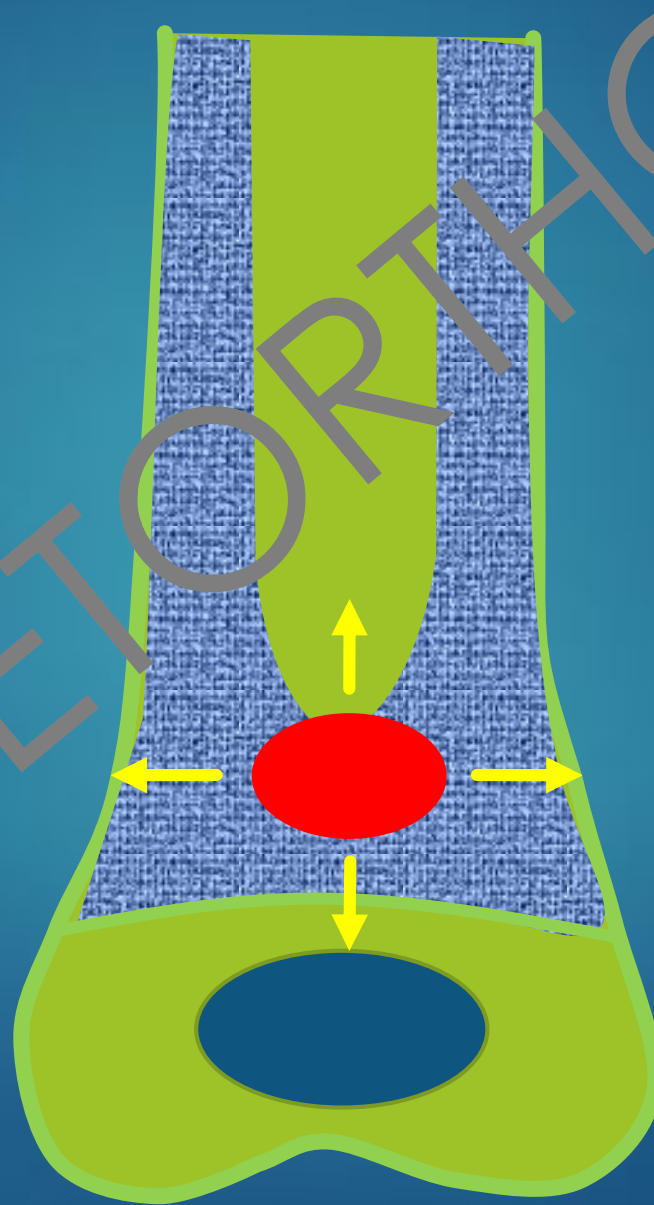


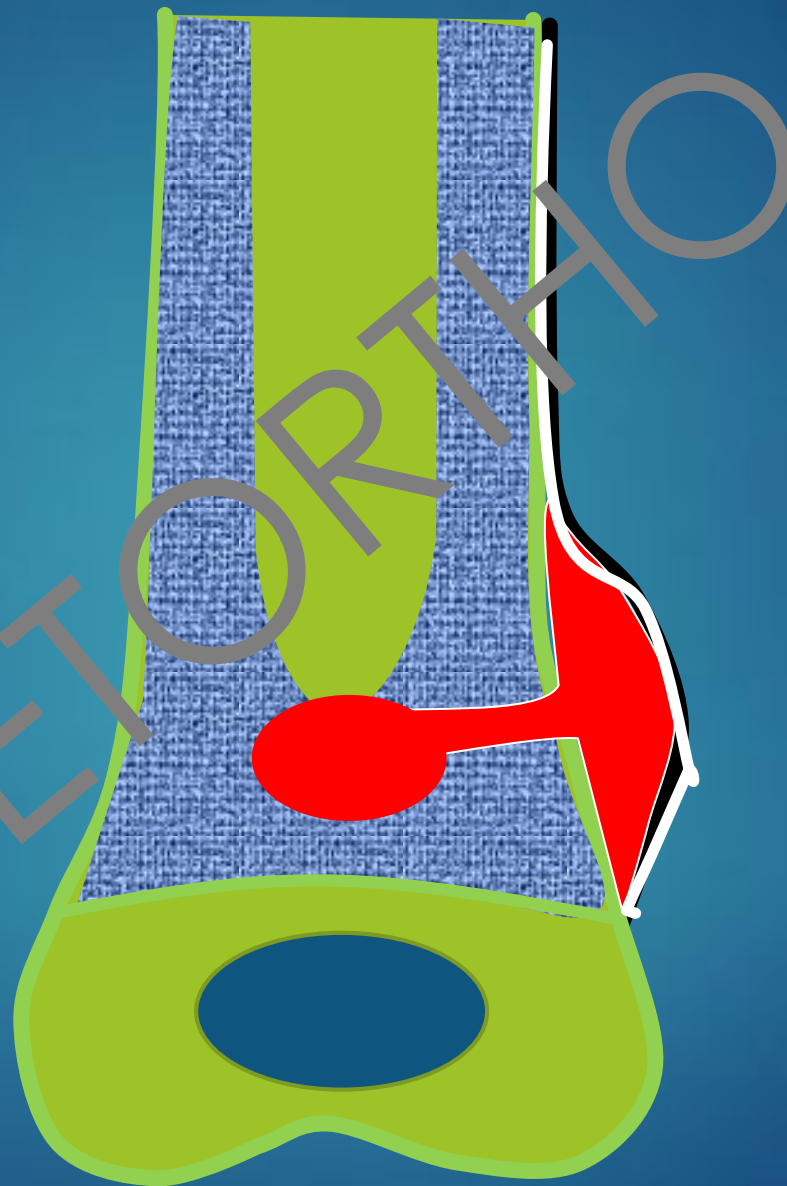
► Exogenous

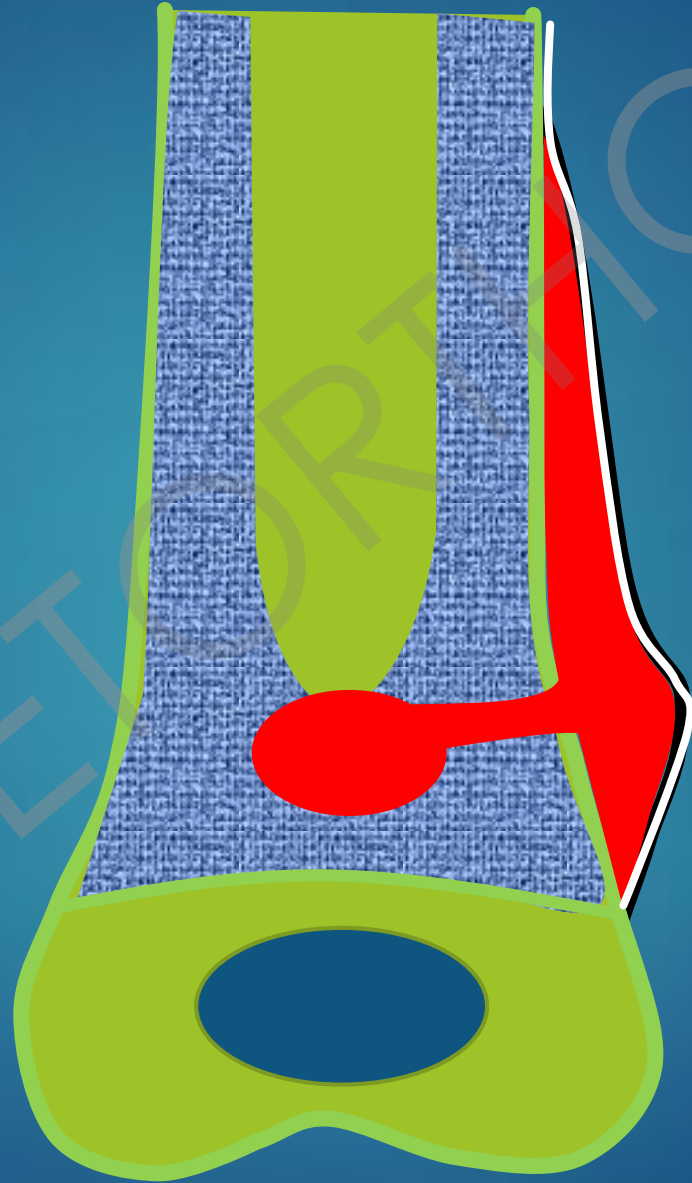


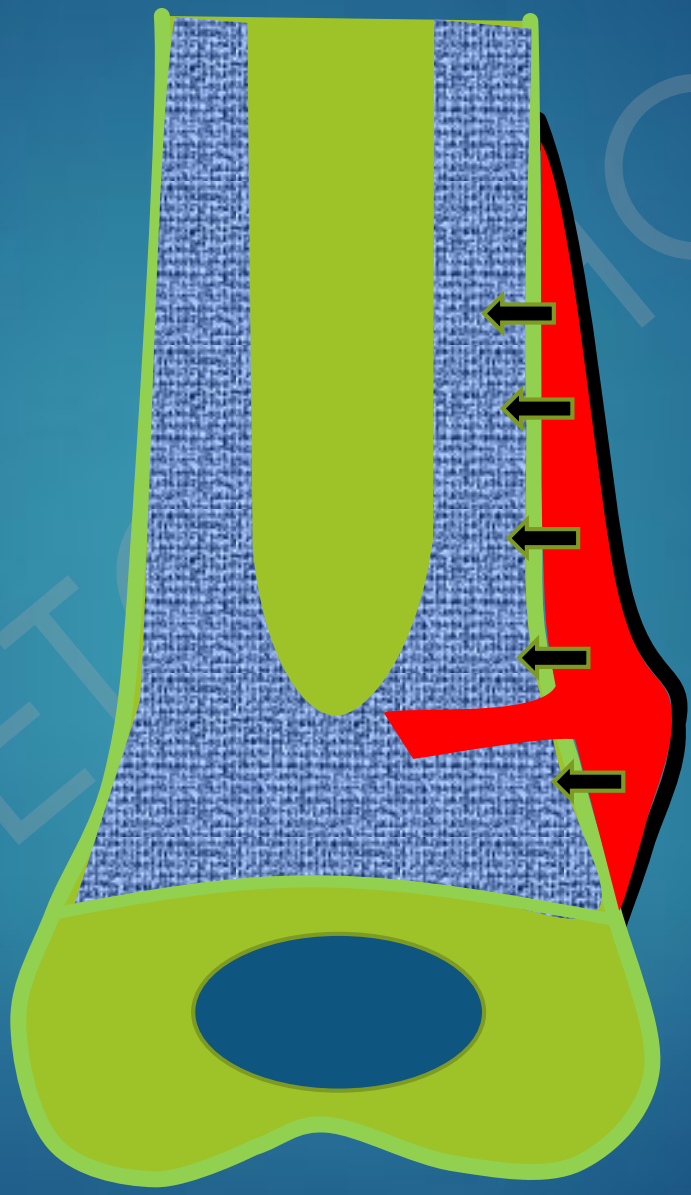
Patho-physiology of Neonatal Osteomyelitis

- ▶ Sluggish metaphyseal blood flow
- ▶ Fewer Phagocytic Cells
- ▶ Hair pin bends

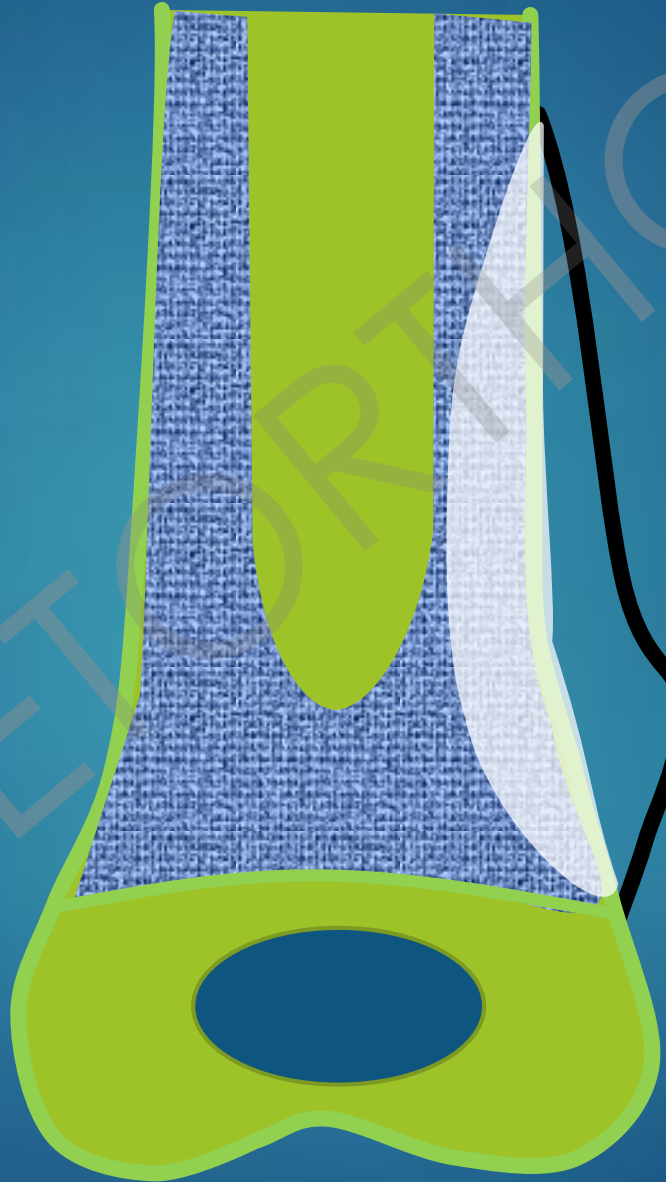




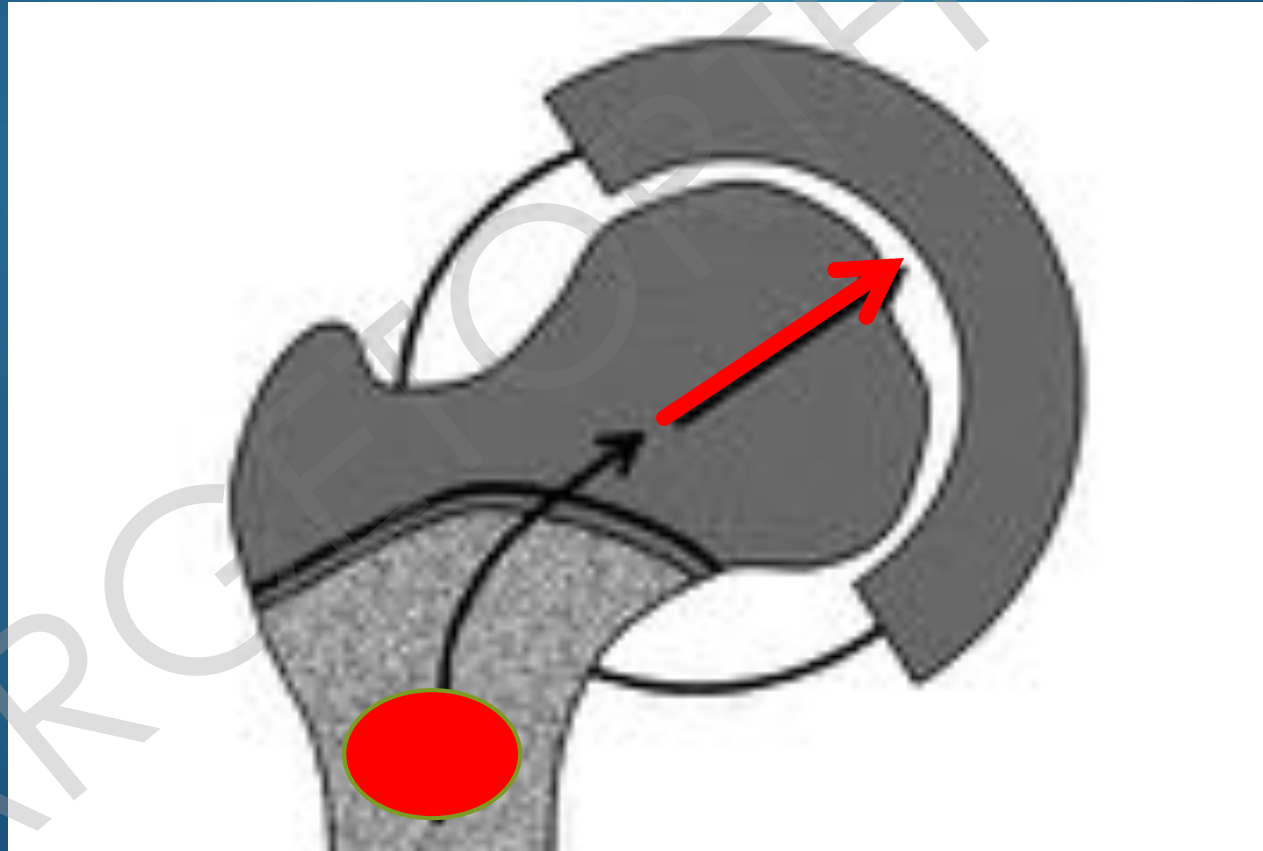


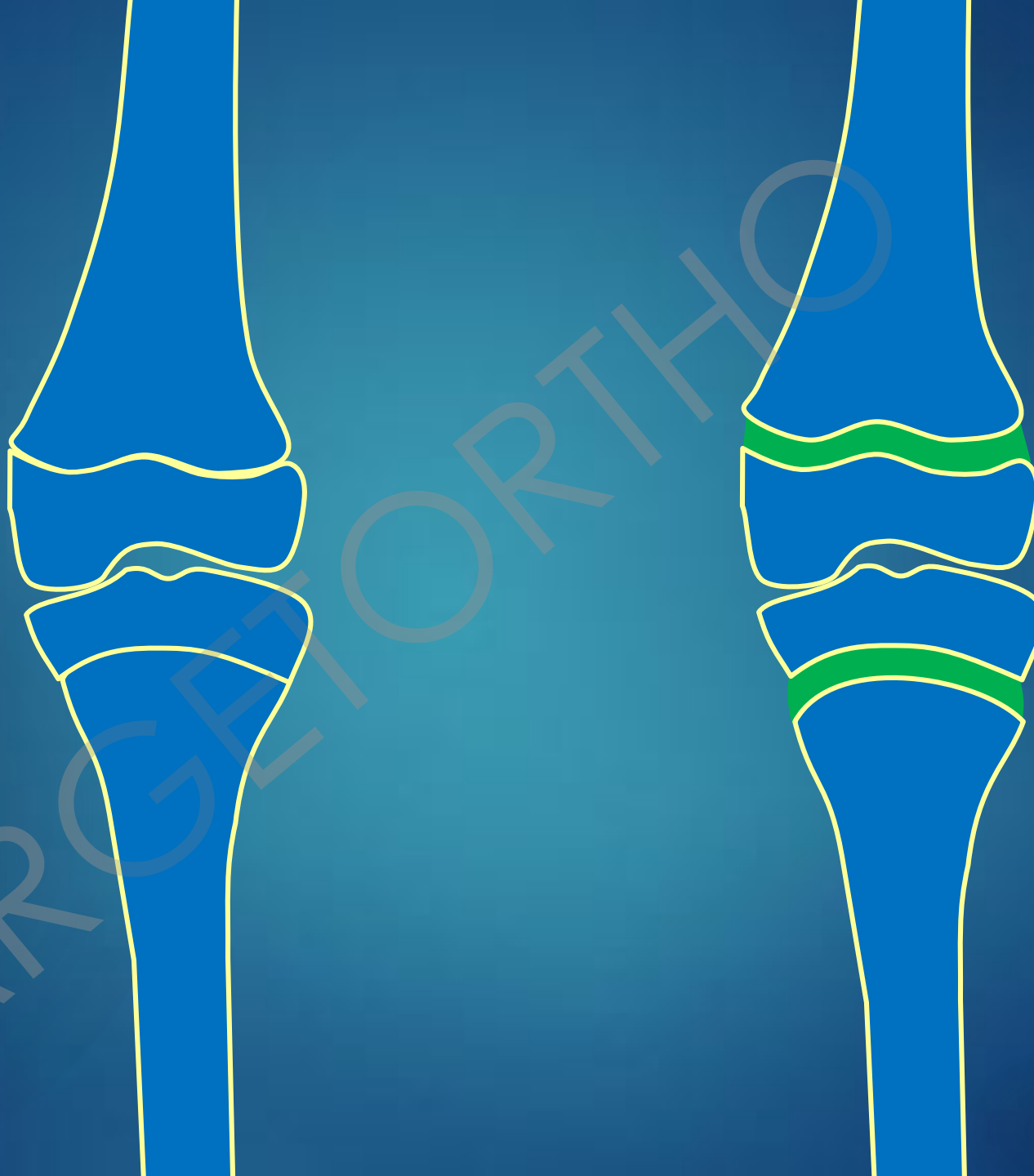


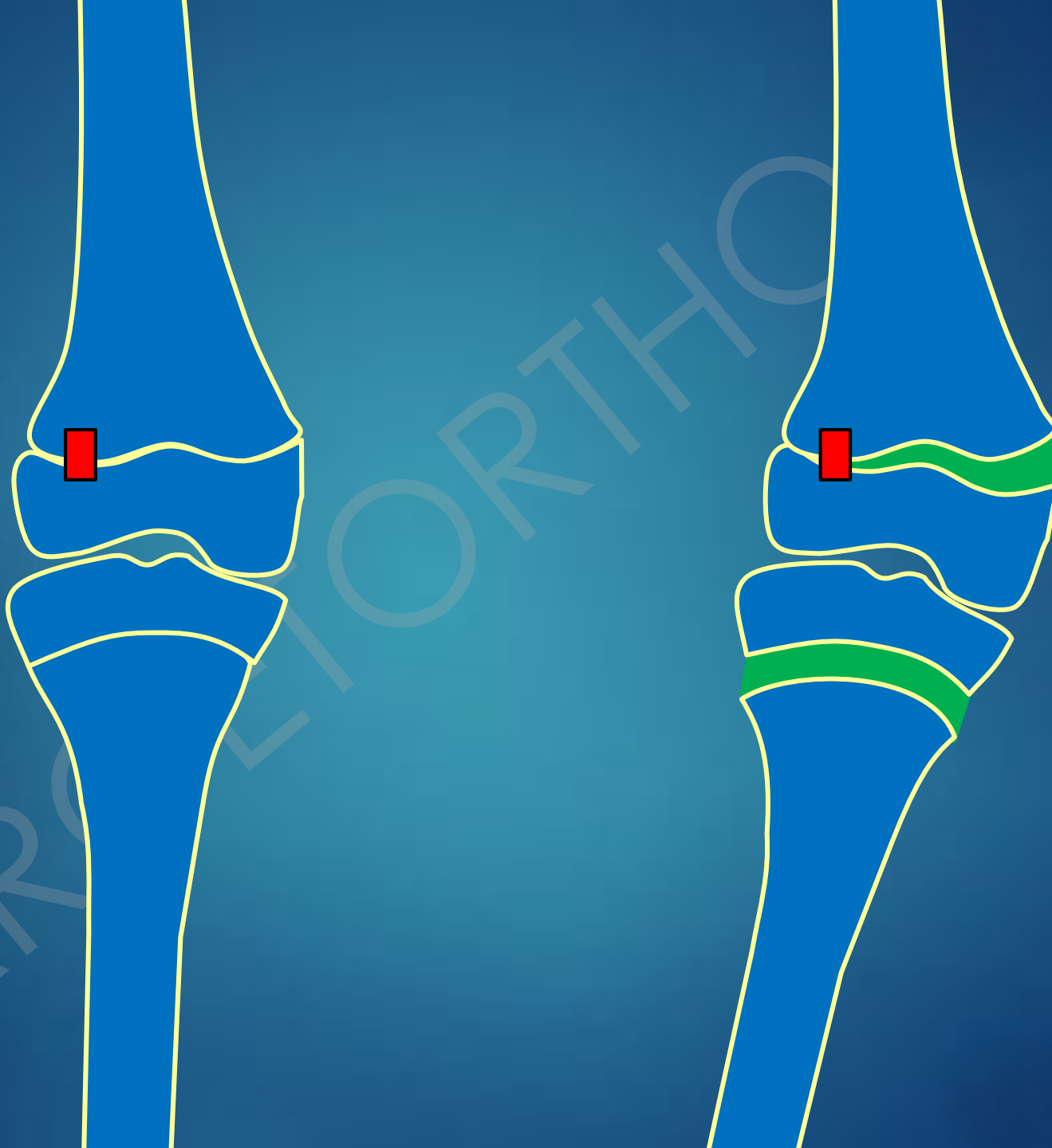
“Circumferential abscess devitalizes the periosteum and makes it prone to pathologic fracture”



Children < 2 Years: Transphyseal Spread to joint







Neonatal Infection

	Pre- term, NICU admission	Healthy , Term Babies
Presentation	Septicemia: Low immunity	Present after 2-3 weeks.
Source of Infection	Nosocomial	Community Acquired> Nosocomial
Diagnosis	Delayed	Prompt
Common Organism	Gm -ve, Fungal, MRSA	Staph. Aureus, Streptococcus CA - MRSA

Circumferential abscess
devitalizes the periosteum and
makes it prone to pathologic
fracture- TSRH 2010; JBJS Am

THE VASCULAR CONTRIBUTION TO OSTEOGENESIS

I. Studies by the Injection Method

J. TRUETA and J. D. MORGAN, OXFORD, ENGLAND

From the Nuffield Orthopaedic Centre, Oxford

Microbiological

- ▶ Most Common: Staphylococcus Aureus
- ▶ Hospital acquired/ IV Drug Users: Pseudomonas
- ▶ NICU Graduate, Chronic ill: Fungal
- ▶ Sick cell hemoglobinopathy: Salmonella
- ▶ **Infants:** Group B streptococcus; Gram Neg coliform, H influenza.



Microbiological

- ▶ Recent trend of **increase in prevalence of MRSA**.

Hospital acquired. In Indian setting Community acquired MRSA also.

Polyarticular/ Multiple bone involvement

DVT Association

- ▶ **Klingella Kingae** infection (K. Kingae) : Requires PCR.

Diagnosis

- ▶ History of NICU admission
- ▶ Long term IV antibiotic
- ▶ Decreased feed
- ▶ Immunocompromised

Diagnosis

- ▶ Irritable
- ▶ Pseudoparalysis
- ▶ Failure to thrive
- ▶ Fever



Diagnosis

- ▶ Irritable
- ▶ Pseudoparalysis
- ▶ Failure to thrive
- ▶ Fever
- ▶ **Local warmth/
Tenderness/ Sign
of active
inflammation**



Diagnosis

- ▶ Irritable
- ▶ Pseudoparalysis
- ▶ Failure to thrive
- ▶ Fever
- ▶ Local warmth/
Tenderness/ Sign of
active
inflammation
- ▶ **Active Sinus/
Discharge**



Diagnosis: Laboratory

Test	Value	Relevance
CBC (ANC)	>12000	ANC Important
CRP	>200mg/ L	95% sensitive. High NPV Response. VTE
ESR	>20 mm/ hr	94% Sensitivity
Xray	1 st : Soft tissue shadow in 48 Hr	Periosteal at 7 day.
MRI	T1 Hypo T2 Hyper	Involvement of bone. Limited by time and cost
CT	Sequestrum	Limited in pediatric
PCR	For K Kingae and other	Rarer in Indian setting
WGS	MRSA Variant.	Culture neg. Cost limit

Not effective in K
Kingae

Alpha defensin, Interleukin etc. are relevant in

PJI

Not much studied in pediatric MSKI

International Journal of Paediatric Orthopaedics | January-April 2022; 8(1): Page 14-23

Diagnosis of Pediatric Musculoskeletal Infections: Current Concepts Review

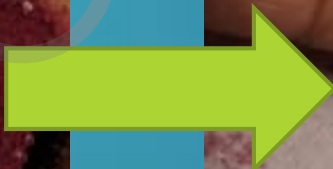
Neeraj Vij ^{BS 1}, Jessica Burns ^{MD 2}, Melissa Esparza ^{MD 2},
Alexandra Dominianni ^{BA 1}, Yerin Cho ^{BS 1}, Mohan V Belthur ^{MD 1,2}

Management

► Acute Osteomyelitis:

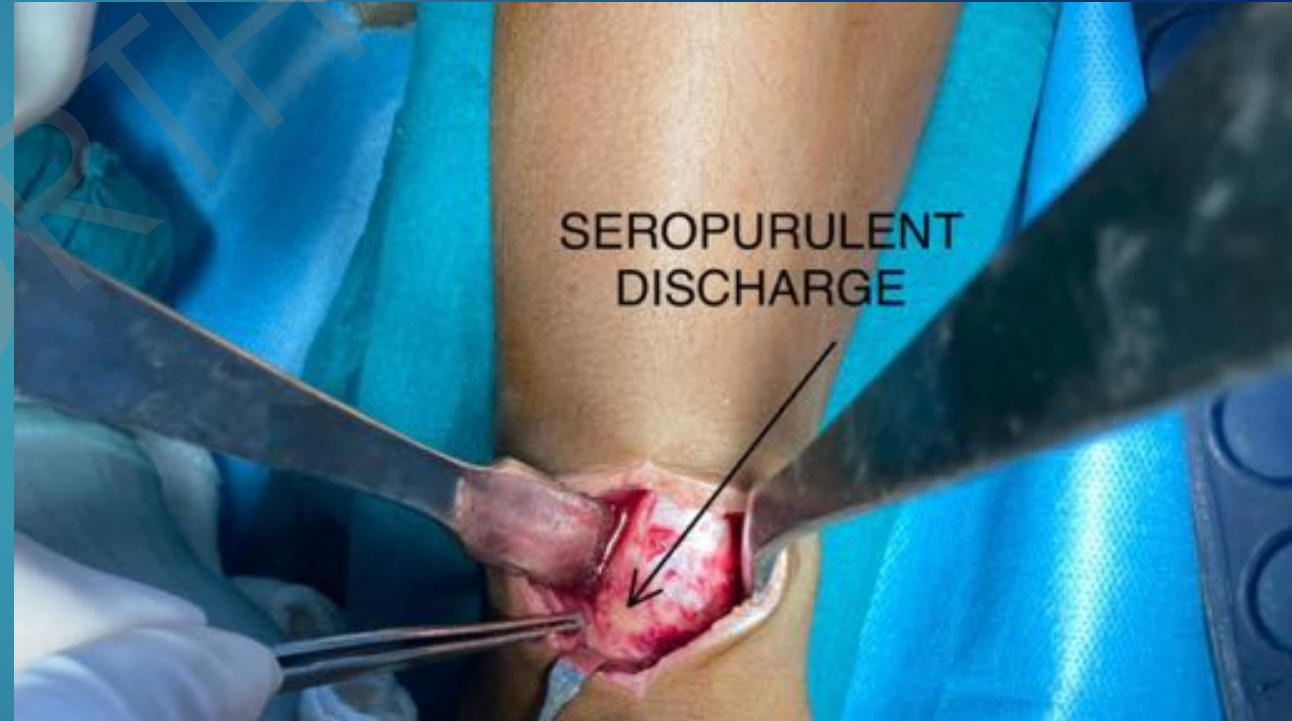
► Nade's Principles

1. Appropriate antibiotic B4 Abscess
2. Abscess formed -> Surgical removal
3. Antibiotic prevent reformation after removal
4. Surgery should not damage normal bone
5. Antibiotics continue after surgery



Acute osteomyelitis

- ▶ Antibiotic limited role before abscess formation
- ▶ If subperiosteal abscess -> Drainage and Bone window.
- ▶ Antibiotics atleast 4-6 weeks.



Antibiotics

- ▶ Broad spectrum:

Gram +: Cephalosporin

Gram -: Fluoroquinolones

- ▶ Blood culture

- ▶ Intra op sensitivity

Subacute Osteomyelitis

- ▶ Relatively milder course
- ▶ Insidious onset
- ▶ Lacks severe symptoms
- ▶ Indolent course
- ▶ Host resistance; Lower virulence; Early but inadequate antibiotic treatment.



Classification of Subacute OM

Type	Gledhill
1	Solitary Localized radiolucency with reactive new bone formation
2	Metaphyseal radiolucency with erosion
3	Cortical Hyperostosis in diaphysis
4	Onion skin layerin; Subperiosteal new bone



Epiphyseal Osteomyelitis

Primary epiphyseal osteomyelitis is relevant in our setting

Tuberculosis

K Kingae

Staphylococcus Aureus

Debridement and antitubercular therapy gives good result

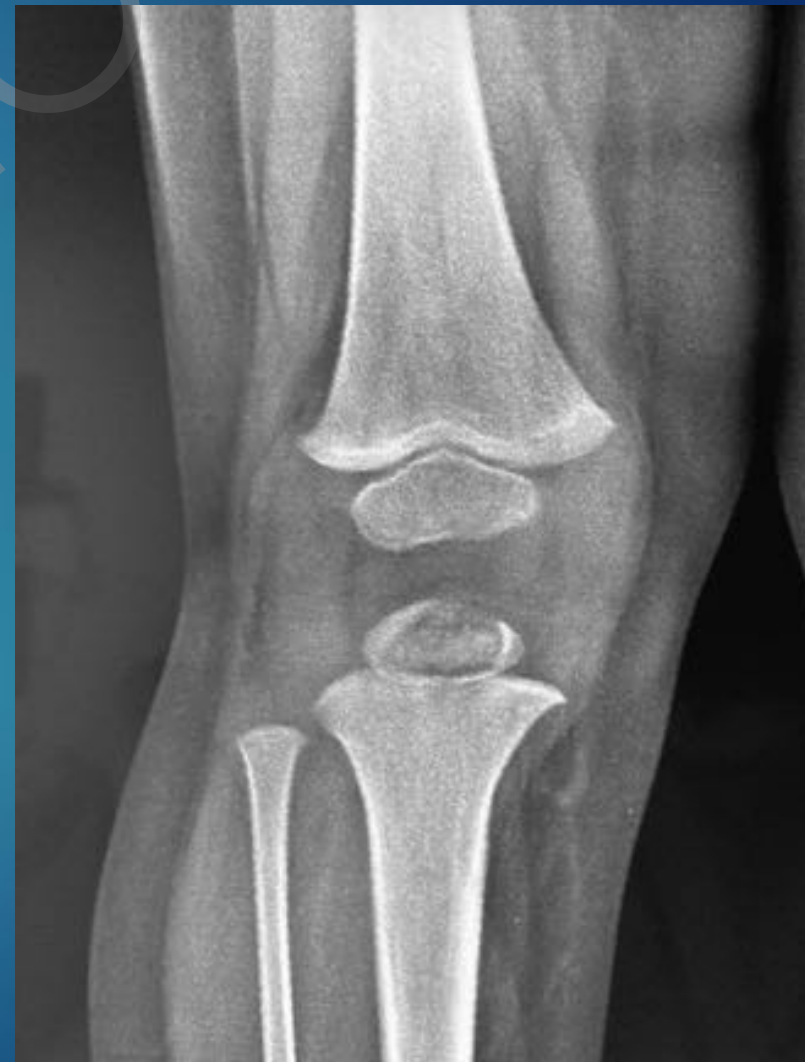
Limited angular deformity

> J Pediatr Orthop. 2020 Aug;40(7):361-366. doi: 10.1097/BPO.0000000000001551.

Primary Epiphyseal Osteomyelitis (PEO) in 18 Children: A Rare Entity With Atypical Features

TARGET

Muhammad M. Shah¹, Gaurav Gupta¹, Akash S. Makadia², Qaisur Rabbi¹



Chronic osteomyelitis

- ▶ Discharging sinus
- ▶ Rough border
- ▶ Granulation tissue (infected)
- ▶ The hallmark of chronic osteomyelitis is :
“Infected dead bone within a compromised soft tissue envelope”

Imaging

X-ray

- Sequestrum
- Involucrum
- Cloacae
- Cavity
- Irregular bone thickening
- Pathological fracture

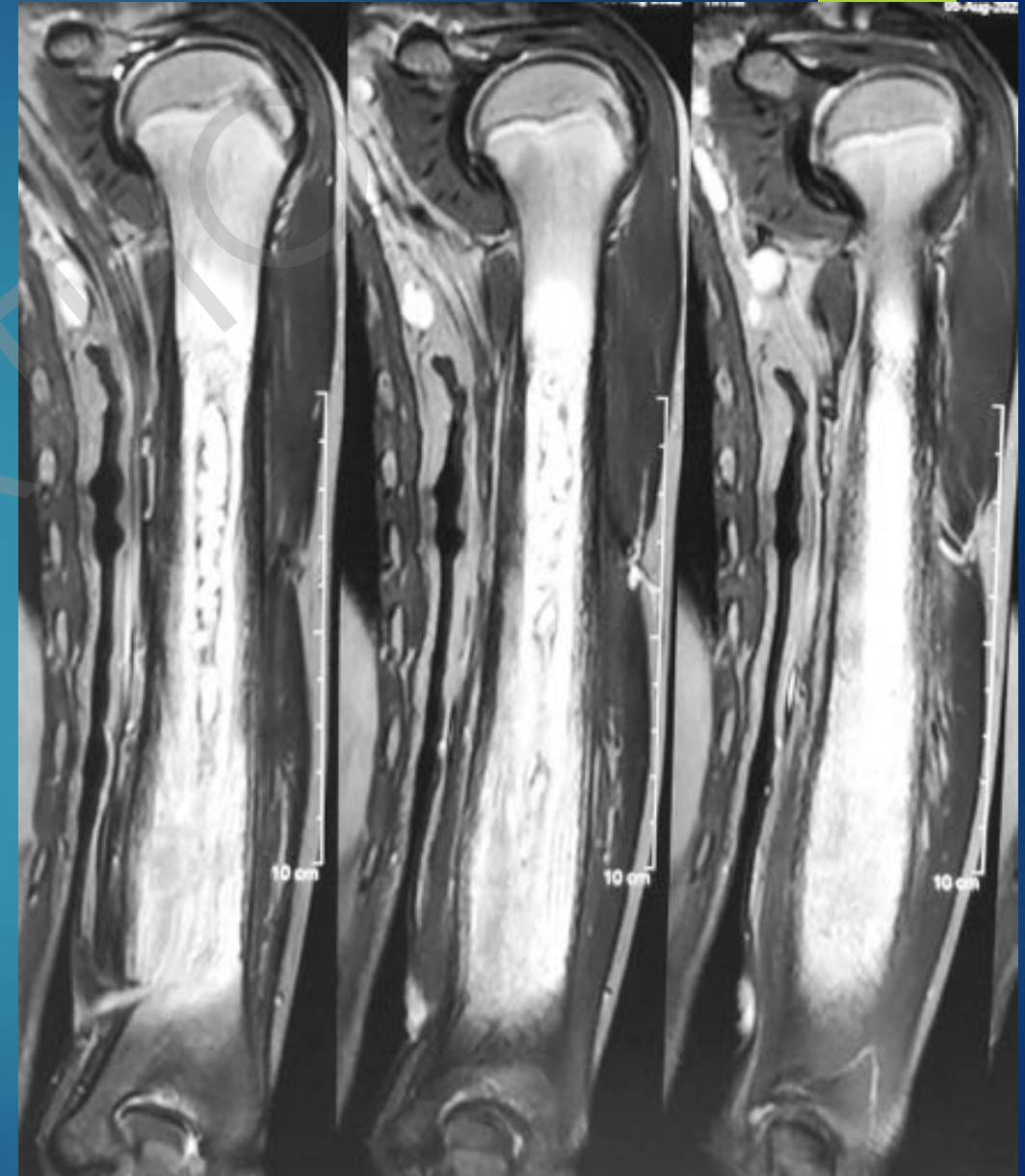


CT Scan

- To identify areas of necrotic bone/ sequestra
- Help in establishing a surgical plan

MRI

- High sensitivity & specificity for diagnosis
- Localises abnormal bone marrow early
- Can detect myositis, cellulitis, sinus tract formation & soft tissue abscess
- **“Rim sign”**-in chronic OM is high signal intensity surrounding the focus of active disease



Radionuclide scan

- Used when diagnosis is ambiguous
- Gauges extent of bone & soft tissue inflammation
 - ^{99m}Tc (High NPV)
 - ^{67}Ga Gallium citrate
 - ^{111}In Indium labelled leukocytes-ideally for acute OM.
- MRI-is much more sensitive than nuclear studies .
- During the 1st post-op year MRI can not accurately distinguish infection from fibrovascular scar—
COMBINED NUCLEAR MEDICINE STUDIES WERE FOUND TO BE MORE USEFUL DURING THIS



¹⁸FDG PET Scan

Meta-analysis showed –Fluorodeoxyglucose positron emission tomography has the highest accuracy for confirming or excluding the diagnosis of Chr OM

“The Accuracy of Diagnostic Imaging for the Assessment of Chronic Osteomyelitis: A Systematic Review and Meta-Analysis”

The Journal of Bone and Joint Surgery (American). 2005;87:2464-2471.

Chronic osteomyelitis

- ▶ Management consists of :

Radical debridement; Dead space management;
Avoidance of complications.

- ▶ Squamous cell carcinoma is a known rare complication of malignant transformation of chronic osteomyelitis.

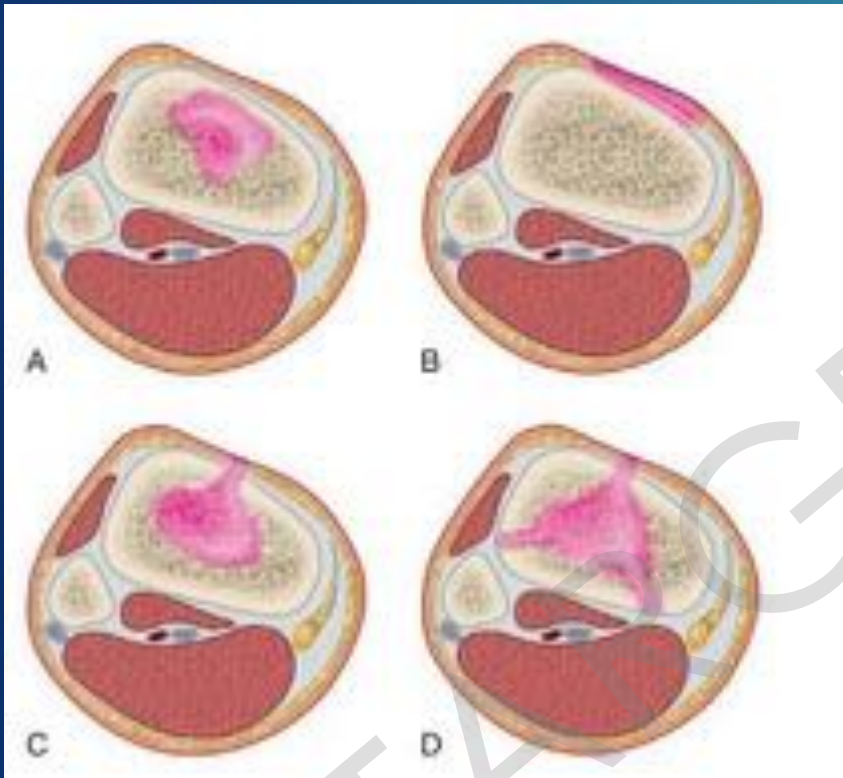
Classification: Cierny and Madar

A: Medullary: Endosteal disease

B: Superficial: Cortical surface infected

C: Localized: Cortical sequestrum that can be excised without compromising stability

D: Diffuse: Mechanical instability before or after debridement



*In Physiologic Host: Normal/ Compromised/
Prohibitive*

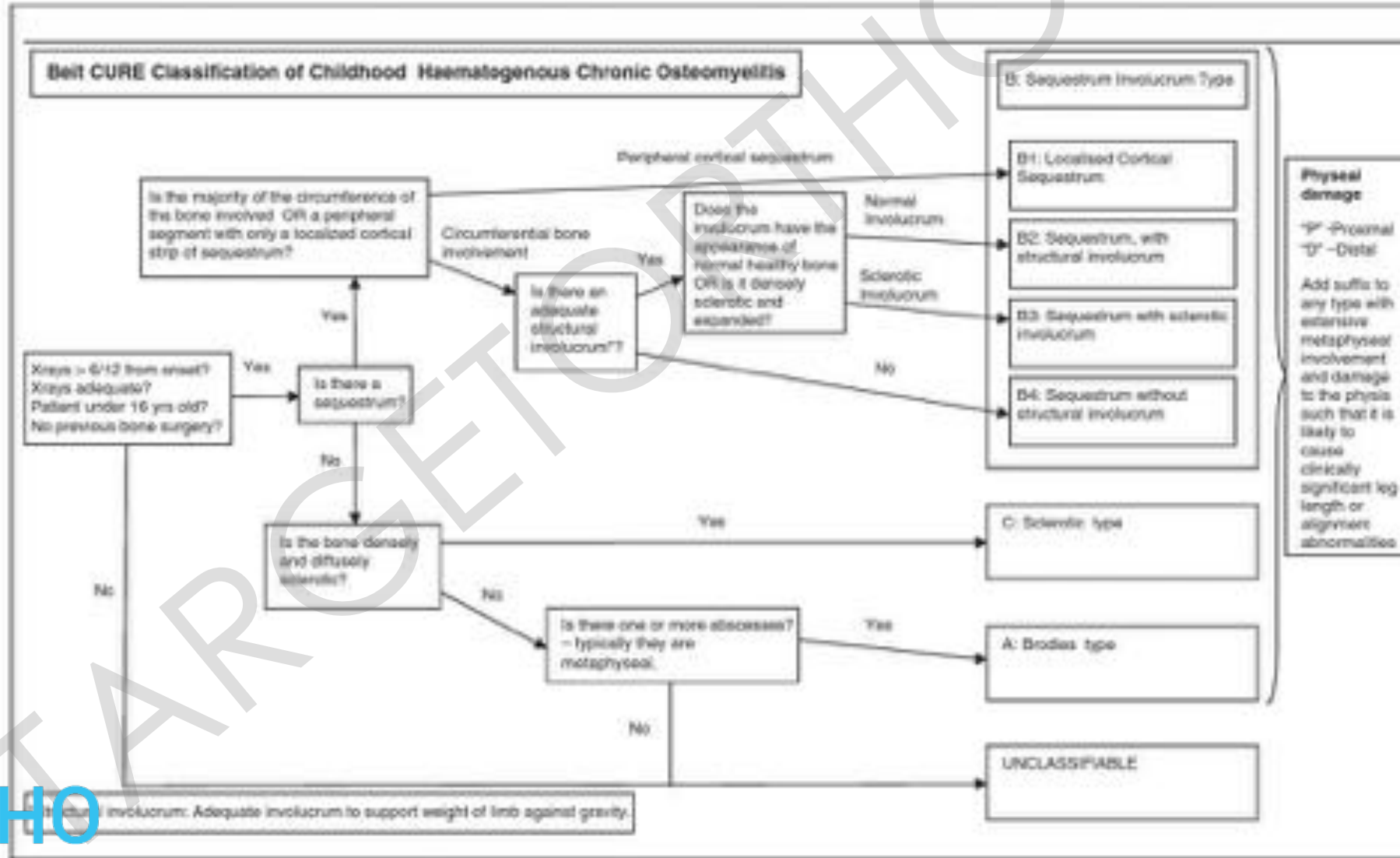
- ▶ Radiologic Classification of Chronic Hematogenous
 - ▶ Osteomyelitis in Children

*Henry Wynn Jones, FRCS (T&O), James W. Harrison, FRCS (T&O),
Jeremy Bates, FCS (ECSA), Gwyn A. Evans, FRCS, and Nicolas Lubega, FCS (ECSA)*

*J Pediatr Orthop Volume 29, Number 7, October/November 2009
Chronic Hematogenous Osteomyelitis in Children*

Classification (Jones)

TABLE 1. Flow Chart Illustrating How to Classify a Case Using Preoperative Overpenetrated Radiographs



Beit CURE Classification of Childhood Haematogenous Chronic Osteomyelitis



Example of type A: Brodie's abscess within a distal tibia



Example of type C: sclerotic tibia.

Beit CURE Classification of Childhood Haematogenous Chronic Osteomyelitis



B1: localised cortical sequestrum of a tibia.



B2: sequestrum with normal structural involucrum of a proximal humerus.

Beit CURE Classification of Childhood Haematogenous Chronic Osteomyelitis



Example of type B3:
Sequestrum with
sclerotic involucrum



B4: Sequestrum with
inadequate
involucrum of a tibia.



Type C: Sclerosis

Beit Cure classification relevance:

- ▶ Type A

Drilling and curettage of abscess OR 6 weeks of antibiotics.

- ▶ Type B1–B3

Sequestrectomy and curettage.

- ▶ Type B4

Sequestrectomy and curettage AND stabilisation

Reconstruction of defect

- ▶ Type C

Drainage and curettage of any collection and long-term antibiotics (6 week minimum).

OPERATIVE TREATMENT

Bone debridement

- Complete removal of all infective / devascularized tissue – only solution to eradicate infection—a/b cannot reach
- “Paprika sign” –punctate bleeding
- Extent of operative debridement- (*simpson et al*)
- >5 mm wide resection-no recurrence
- <5 mm marginal resection had recurrence of 28%
- Extent of debridement is much more important in B hosts
- Cortical window- at weakest area of the involucrum
 - connect a series of drill holes
 - should be oval to minimise risk of #

When to do sequestrectomy?

Early sequestrectomy

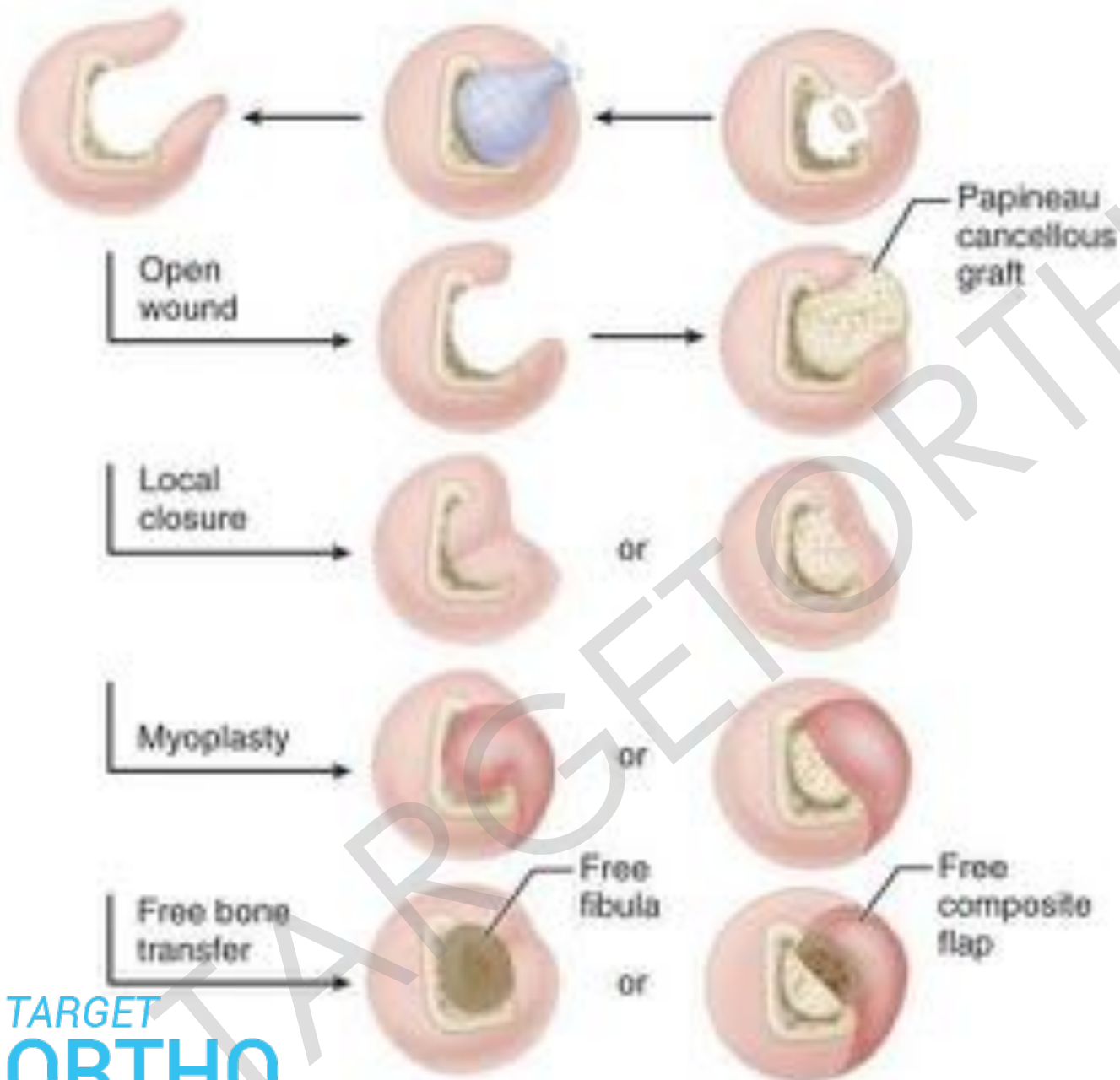
- Eradicate infection
- Better environment for periosteum to respond

Delayed sequestrectomy

Wait till sufficient involucrum has formed before doing a sequestrectomy to minimize the risk of cx, fracture, deformity & segmental loss

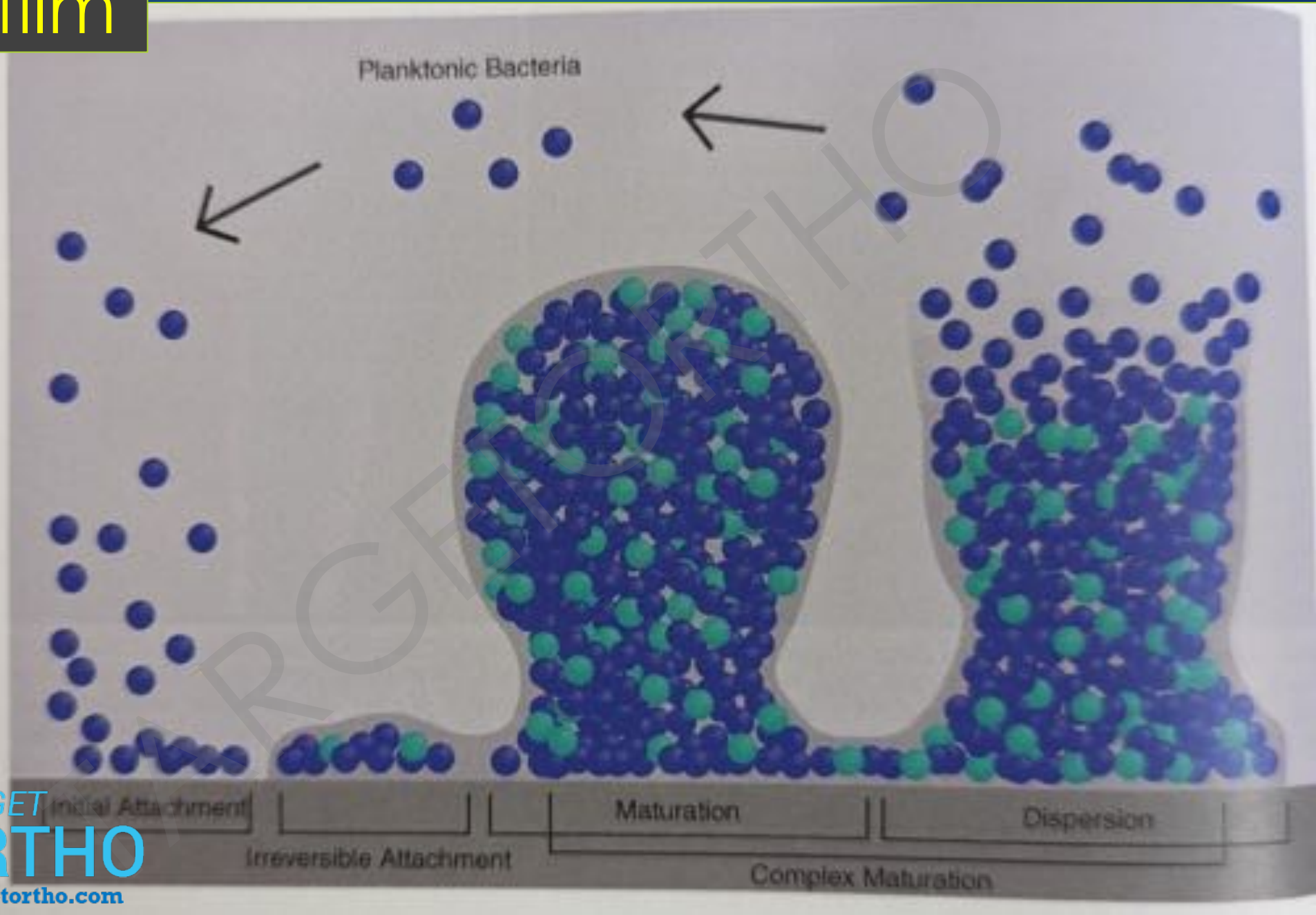
In either case it is critical to preserve the involucrum

preferable to wait at least 3-6 mo before performing a sequestrectomy



- Papineau + VAC therapy
- Flaps

Biofilm



Cement Bead/ Spacer

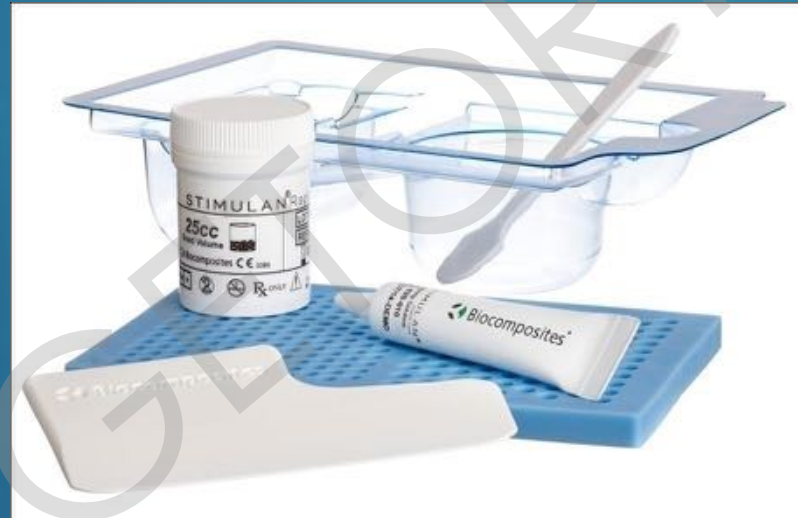
- ▶ Masquelet 2 stage technique
- ▶ Cement spacer
- ▶ Fibrous envelop
- ▶ Bone graft and fixation



What's New In the treatment of Neonatal Osteomyelitis ?

STIMULAN BIOCOMPOSITES

- Absorbable calcium sulphate.
- Delivers antibiotics directly at the site of infection.
- No systemic antibiotic toxicity.
- Predictable elution profile.
- Does not act as a nidus for infection.



Absorbable Calcium Sulphate
bio-composite



Engineered to mix with heat sensitive
antibiotics

Complications

- ▶ Non Union
- ▶ Re Infection
- ▶ Pathological Fracture
- ▶ Osteonecrosis
- ▶ Septic arthritis
- ▶ Physeal Affection



Case 1

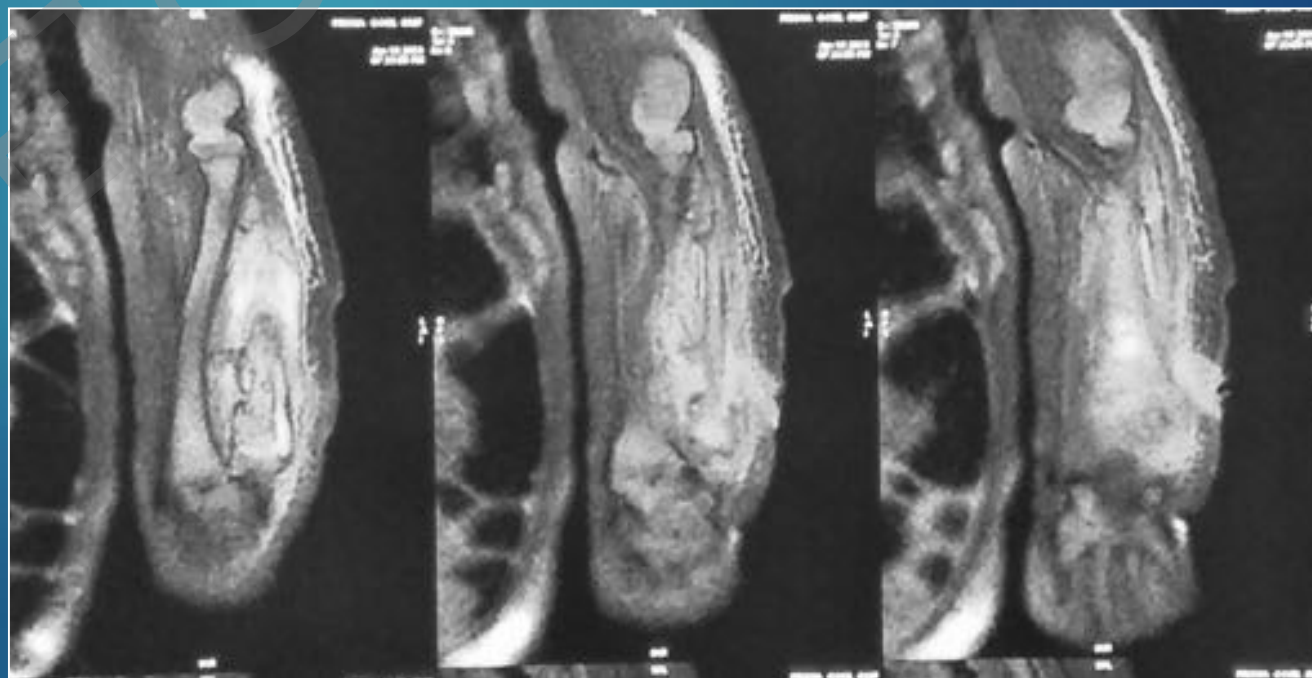


6 wk post injury and 4 week post I and D

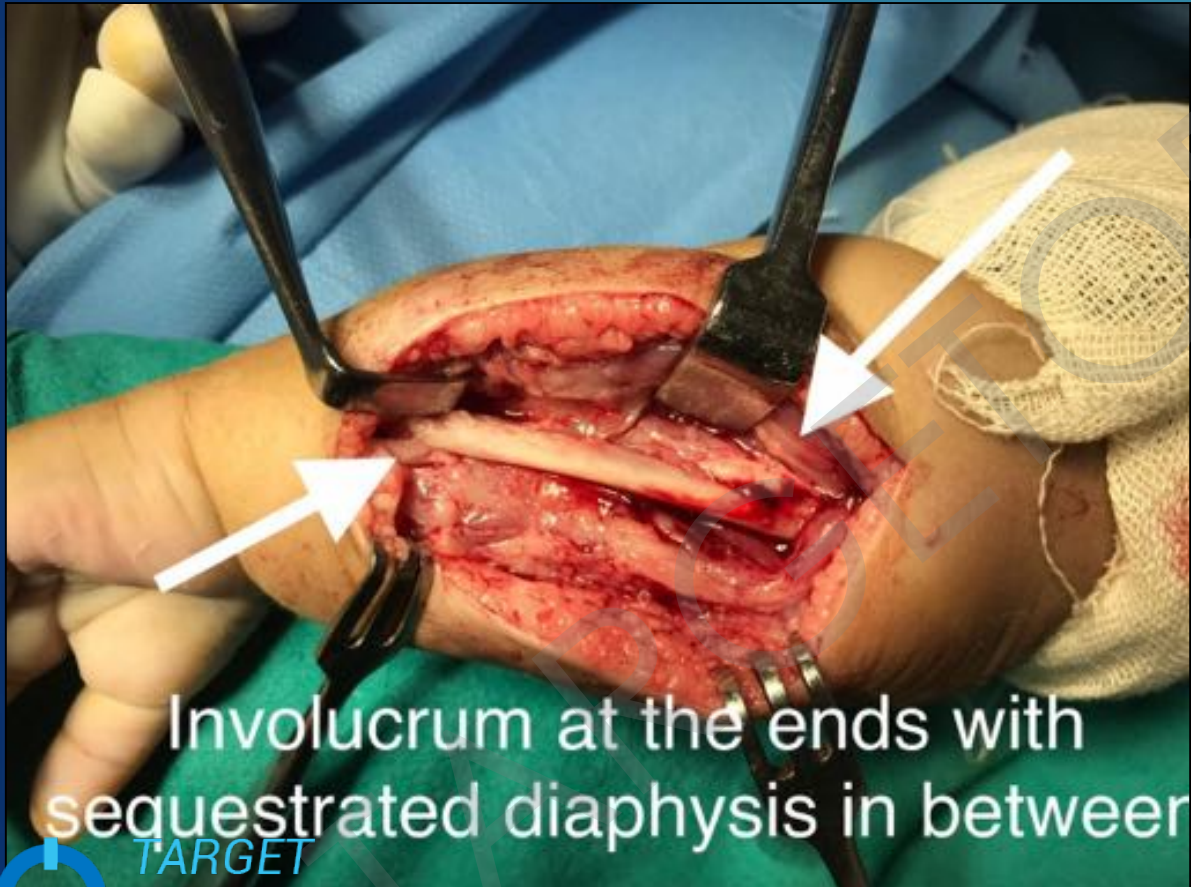


At presentation

TLC	– 23100 Cells /Cu. mm
CRP	– 118
USG left forearm	– Abscess in lower left forearm with extension along periosteum and bone margins.
MRI –	revealed diffuse marrow edema involving whole ulna with sub periosteal abscess and breach in cortex of distal ulna diaphysis.



Procedure done



- ▶ The infected ulna was exposed
- ▶ Union at proximal end with involucrum seen

Procedure done



6 month FU



1 year FU





Two years follow up

Case Courtesy: Orthokids Clinic, Ahmedabad

Case 2

Presentation:

- ▶ 5. 5 months old referred from Paediatrician
- ▶ Decreased movement of right lower limb
- ▶ History of fever on and off
- ▶ Normal perinatal history



Clinical examination

- Irritable child
- Tender thigh
- Relative less movement of right limb
- Already on IV antibiotics



TARGET
ORTHO

(C) www.targetortho.com

Investigation	Report
TC	14000
CRP	32
Differential N/L/E/M	70/25/3/2



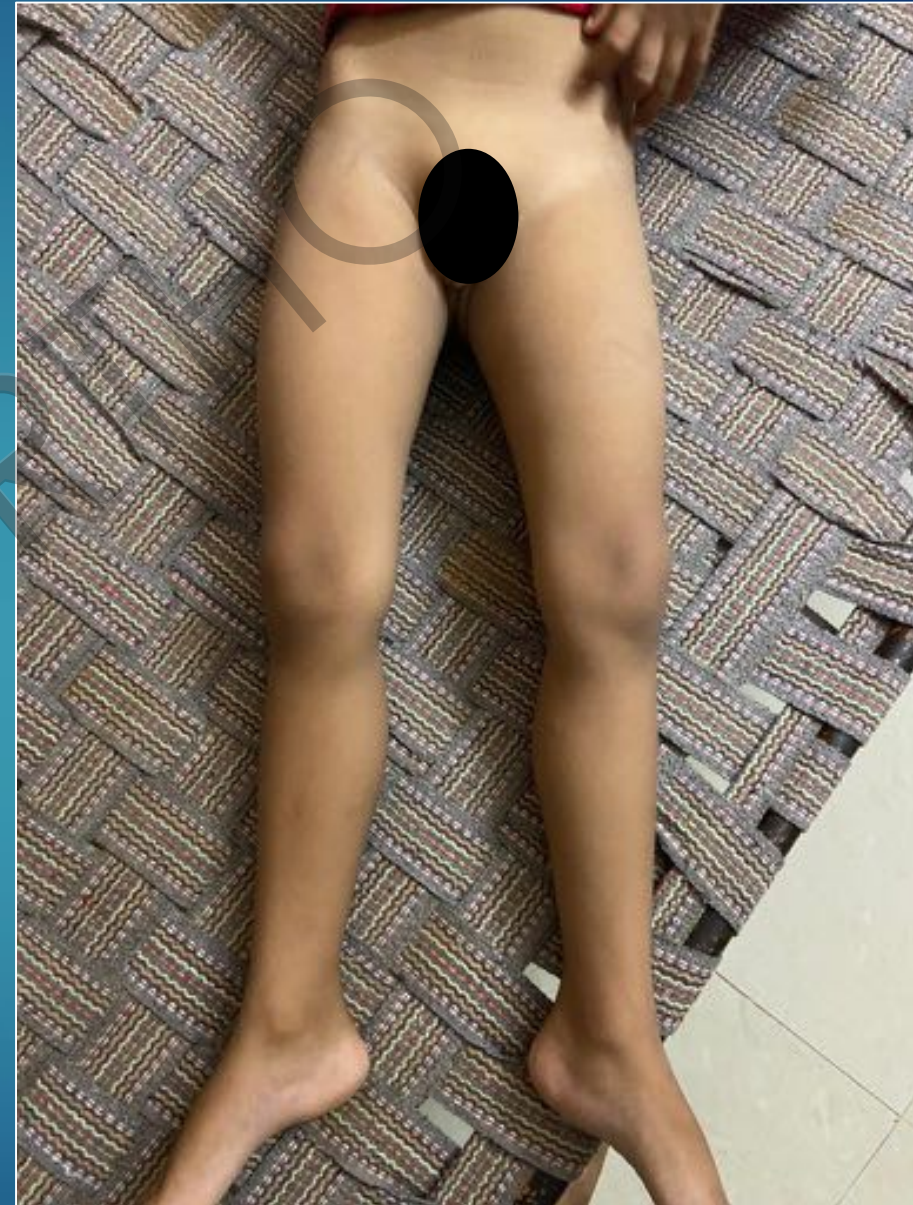
Points Missed?

- ▶ Head to toe examination
- ▶ Recent infection history
- ▶ Diaphyseal Osteomyelitis Femur?





Caffey's Disease



What is Caffey's disease?

- ▶ Caffey disease or infantile cortical hyperostosis is a largely self-limiting disorder which affects infants. It causes bone changes, soft-tissue swelling, and irritability.

Case 3

- ▶ 14 years old boy
- ▶ Right leg pain complain since 15 days
- ▶ Consulted a General Orthopaedic surgeon
- ▶ Advised MRI and Blood workup

Blood work up

Test Name	Result
Hemoglobin	11.3 gm%
WBC count	13500/cmm
ESR	24mm/hr
CRP	8.1mg/dl



MRI of Left Tibia Suggestive of

IMPRESSION:

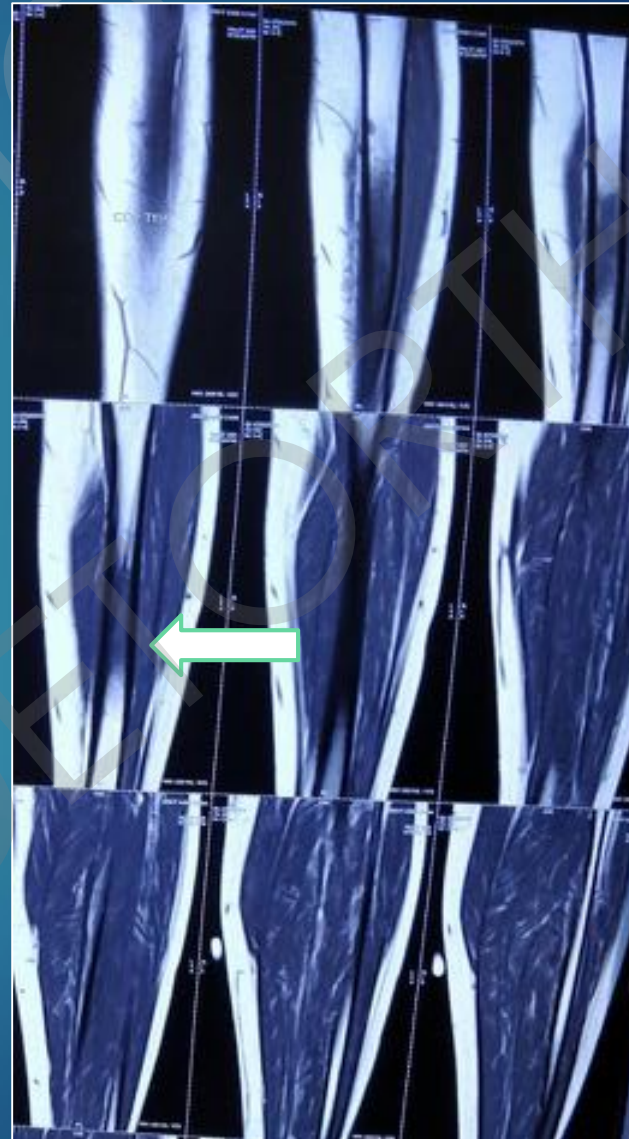
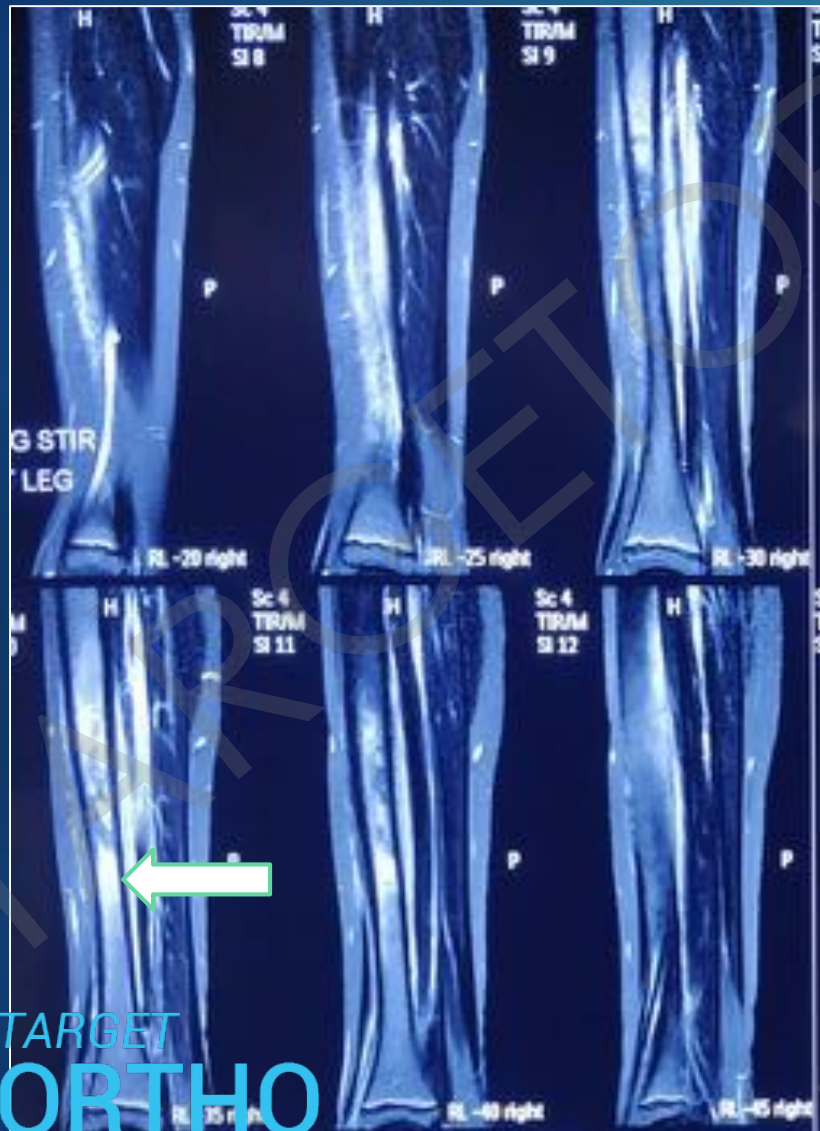
The MR findings are:

- Ill-defined Marrow Oedema involving medullary cavity of middle 1/3rd of shaft of left tibia with discrete internal hypointense areas and discrete Patchy Marrow Oedema within adjacent tibial cortex with solid continuous Periosteal Reaction and mild adjacent Soft-Tissue Oedema, suggest possibility of Acute Osteomyelitis.
- No evidence of soft-tissue lesion or collection in left leg or sinus formation in adjacent soft tissue.

X ray



MRI



Diagnosis

CRMO- Chronic recurrent multifocal
osteomyelitis

CRMO:

- ▶ Autoinflammatory disorder
- ▶ Insidious onset of pain with swelling and tenderness localised over the affected bones.
- ▶ Involvement of the clavicle is the classical picture
- ▶ Diagnosis of CRMO is made by exclusion

Case 4









MDCT SCAN OF LEFT HIP JOINT AND LEFT FEMUR

Axial scans were obtained through left hip joint and left thigh.

There is fracture seen in proximal shaft of femur with presence of internal metallic fixator and irregular large periosteal thickening in proximal - mid femoral shaft with perifocal large hypodense collection (approx 24x78x156mm) along anterior - lateral aspect at inter-intramuscular plane.

There is mild hip joint effusion seen on left side.

Heads of femora lie well within the acetabular cavities.

Articular surfaces of acetabula and femora show no erosion or sclerosis.

CONCLUSION:

- Fracture seen in proximal shaft of femur with presence of internal metallic fixator and irregular large periosteal thickening in proximal - mid femoral shaft with perifocal large hypodense collection along anterior - lateral aspect at inter-intramuscular plane - P/o infective etiology

- Mild hip joint effusion seen on left side

Clinical correlation

Ix	Report
Hb	7.7 g/ dL
Total count	9730/ cmm
CRP	14

- ▶ Biopsy was performed at one centre
- ▶ It showed inflammatory cells. Culture was negative



Non-Union of the Ulna in a Ten-Month-Old Child Who Had Type-IV Hereditary Sensory Neuropathy

A CASE REPORT*

Case Report

Catastrophic results due to unrecognized of congenital insensitivity to pain with anhidrosis in children with multiple long bones fractures: A case report of 27 years follow-up of two siblings

Franky Kartono^a, Conny Tanjung^c, Karina E. Besinga^b, Daniel Marpaung^b, Tesi Ananditya^b,
Adfren Budiartha Budisantoso^a



FIG. 1-A

FIG. 1-B

FIG. 1-C

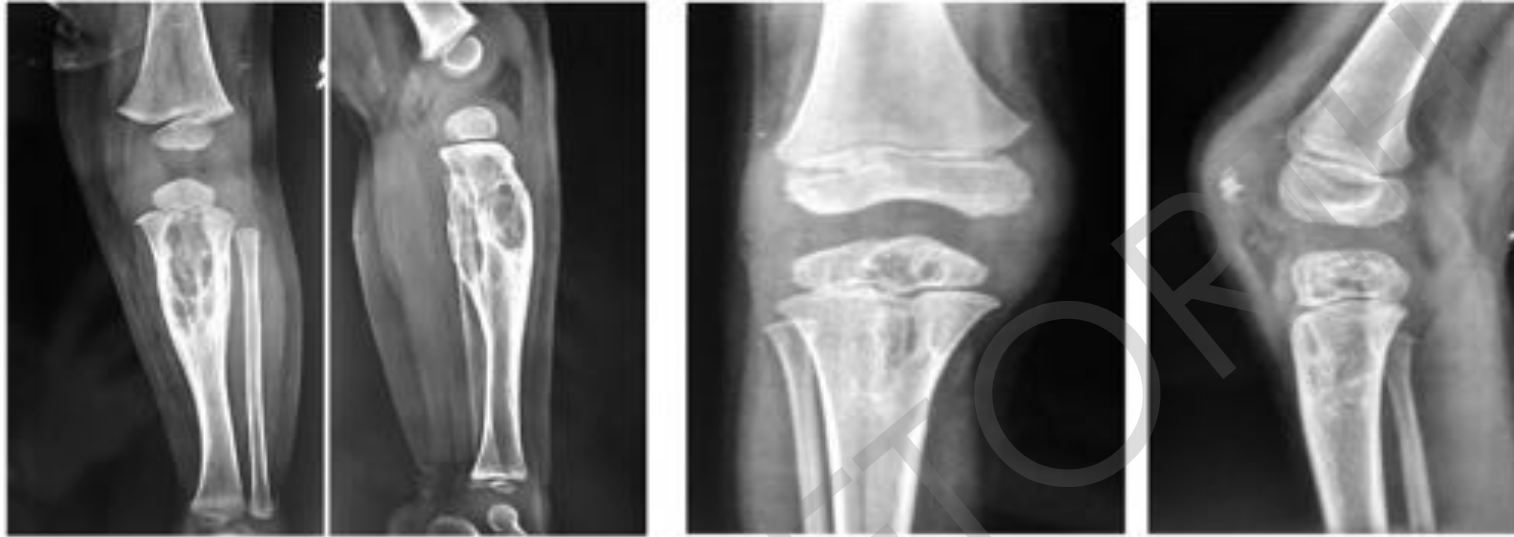
FIG. 1-D

Diagnosis

- CIPA associated hypertrophic callus formation

Case 5

Tuberculosis



Case 6

► 14 Year male known case of CML with

- Antalgic gait
- No swelling / tenderness/ local warmth
- Skin normal
- Terminal restriction of hip movements

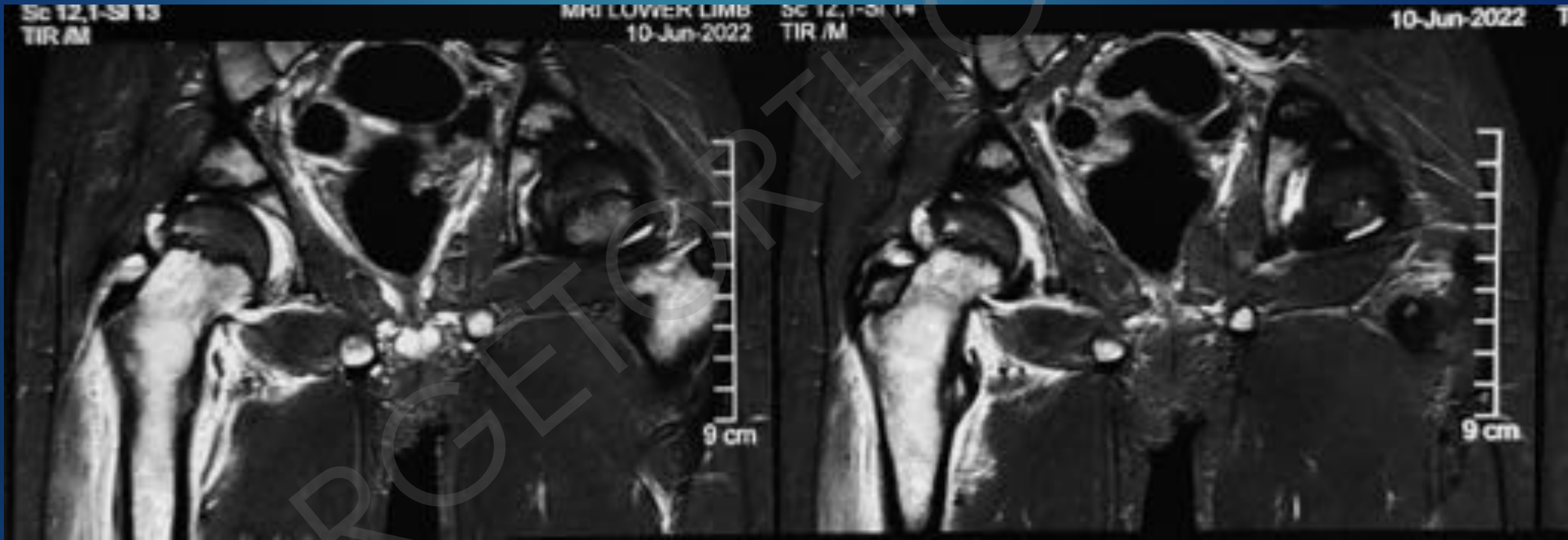


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► MRI reported :

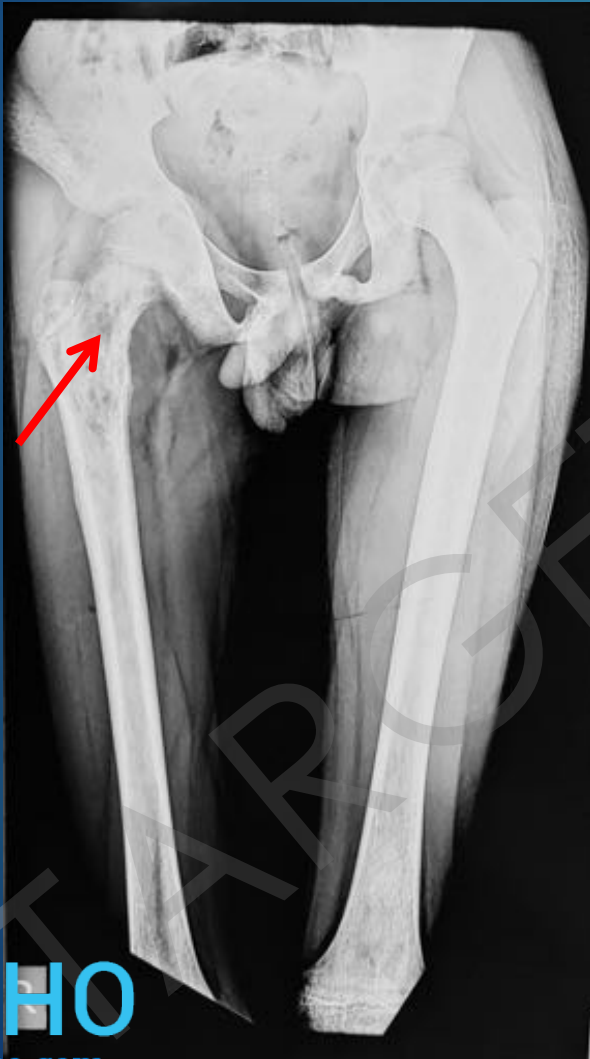
Right Femur Osteomyelitis with Reactive Synovitis
of Right Hip

Blood investigation

Hb	9.4
TLC	5000
PLT	1.8 L
CRP	11



Plan : J needle biopsy from right proximal femur with aspiration of right hip



Cultures – no growth

Histopathology –
Myeloid Sarcoma

“ Culture all biopsies and Biopsy all cultures ”

Case Courtesy: Wadia Hospital, Mumbai

Case 7



Case Courtesy: Wadia Hospital, Mumbai