Fracture Related Infection: Diagnosis & Management



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Fracture Related Infections Learning Objectives

1. Concensus Definition of A Fracture Related Infection (FRI)

2. To Identify Specific Demographic, Injury, and Treatment Risk

Factors For Fracture Related Infections

3. Review Contemporary Methods of Diagnosis & Treatment

Fracture Related Infections Assumptions For This Lecture

- Infection Within 12 Weeks
 - Open Fractures
 - Elective Closed Fractures
- Not Discussing Today
 - Chronic Osteomyelitis
 - Infected Non-Unions
 - Large Segmental Defects



Fracture Related Infection Introduction

- Dreaded Complication
- Adversely Affects Outcome
- Prolongs Treatment
- Increases Cost
- Psycho-Social Issues
- Medical-Legal Issues



Fracture Related Infection Introduction

- If You Treat Fracture Patients You Will Have An Infection
- Best Surgeons Have Them
- Knowledgeable & Prepared
- Get Help (Consultants)
 - Infectious Disease
 - Internal Medicine
 - Radiology / Imaging



Fracture Related Infection Introduction

- Do Not Abandon The Patient When Complications Arise
- Requires Greater Involvement
- Requires Patience & Understanding & Time
- Requires Compassion & Caring
- Be A Doctor



Fracture Related Infection Infection Mitigation In Fractures

- Timely & Aggressive I & D
- Early High Dose Antibiotics
- Staged Surgery
 - Temporary Ext Fix
 - Definitive Management
 - Dead Space / Wound Vac



Fracture Related Infection Infection Mitigation In Fractures

- Careful Soft Tissue Handling
- Indirect Reduction Techniques
- Minimally Invasive Surgery
- Submuscular Plating
- Tension Free Closure
- Incisional Wound Vac



Fracture Related Infection Identification Of Risk Factors

3 Groups

Injury Related Risk Factors

Patient Related Risk Factors

Treatment Related Risk Factors



Fracture Related Infection Injury Related Risk Factors

- Large Zone Of Injury
- High Levels Contamination
- Challenging Environment
- Predisposing Factors
 - Alcohol
 - Drugs



Fracture Related Infection Injury Related Risk Factors

- Anatomic Location
- Mechanism Of Injury
- Fracture Grade
- Severity Soft Tissue Injury
- Associated Injuries



Fracture Related Infection Patient Related Risk Factors

- Smoking
- Diabetes
- Obesity
- ETOH / Drugs
- Immune Status
- Medications



Fracture Related Infection Treatment Related Risk Factors

- Control OR Traffic
- Poor Sterile Technique
- Incorrect Implants
- Prolonged Surgery
- Inadequate Antibiotics



Fracture Related Infection

Until Recently There Was No Standardized Definition of

Fracture Related Infection (FRI)

In 2018 The AO Foundation & European Bone & Joint

Infection Society (EBJIS) Proposed a Consensus Definition

For FRI to Standardize the Diagnostic Criteria & Improve

Outcomes & Applicability of Future Infection Studies

Metsemakers WJ, Morgenstern M, NcNally MA, et. al: Fracture Related Infection: A Consensus On Definition From An International Expert Group Injury 49 (2018) 505-510

Govaert GA, Kuehl R, Atkins BL et al: Diagnosing Fracture Related Infection: Current Concepts & Recommendations J Orthop Trauma 34 (2020) 8-17

Metsemakers WJ, Fragomen AT, Moriarty F, et al: Evidence Based Recommendations For Local Antimicrobial Strategies & Dead Space Management in Fracture Related Infection J Orthop Trauma 34 (2020) 18-29

Fracture Related Infection Definition

Two Levels of Certainty Around Which Diagnostic

Criteria Of Infection Were Defined

Criteria Could Be Confirmatory Or Suggestive

Confirmatory Criteria (Infection Definitely Present)

Suggestive Criteria (Infection Possibly Present)

Fracture Related Infection Confirmatory Criteria

- 4 Confirmatory Criteria (Infection Definitely Present):
 - 1. Fistula, Sinus, or Wound Breakdown
 - Purulent Drainage From the Wound Or Presence of Pus Identified at Surgery
 - Phenotypically Identical Pathogens Identified by Culture
 From at Least 2 Deep Tissue Specimens
 - 4. Gram Stain Presence of Microorganisms in Deep Tissue Taken During Surgery & Confirmed on Histopathology

Fracture Related Infection Suggestive Criteria

• Suggestive Criteria (Infection Possibly Present)

1. Clinical Criteria: Redness, Swelling, Warmth, Fever, etc.

2. Serum Inflammatory Markers: WBC, ESR, CRP

3. Medical Imaging: X-Rays, CT, MRI, Bone Scan, FDG-PET

Fracture Related Infection Diagnosis Suggestive

- Usually Appears <21 Days
- Classic Signs
 - Increased Pain
 - Swelling & Warmth
 - Tenderness
 - Erythema
 - Fever > 38.3 C
 - Wound Drainage



Fracture Related Infection Diagnosis

- Classic Signs Of Infection
- Its Not Likely To Be
 - Tape Allergy
 - Bee Sting
 - Medication Reaction
 - Heating Pad Erythema
 - Overly Emotional Patient



When You Hear Hoof Beats Think Of Horses ; Not Zebra's

Fracture Related Infections Pitfalls

- Don't Fall Into The Trap
 - If It Looks Like A Duck
 - Walks Like A Duck
 - Quacks Like A Duck
 - Swims Like A Duck
- It Is A Duck (Infection)



Fracture Related Infections Diagnostic Studies

- Blood Work: Inflammatory Markers
- CBC, ESR, CRP
- Suggestive Not Confirmatory
- Problem: Considerable Variability

in Sensitivity and Specificity



Fracture Related Infections Medical Imaging

- Conventional Films
- CT Scan
- MRI Scans
- Bone Scans
- FDG-PET Scans



Fracture Related Infections Convention X-Rays

- Assess Fracture Healing
 & Implant Stability
- Easily Available
- Inexpensive
- Quickly Performed
- More Useful in Late Infections



Fracture Related Infections CT Scans

- CT Scans (More Helpful Late)
 - Osseous Destruction
 - Sequestra, Bone Cavities
 - Foreign Body
 - Gas Formation
 - Assess Fracture Healing



Fracture Related Infections MRI Scan

- MRI Scans
 - Better Soft Tissue Information
 - Better Anatomical Resolution
 - Visualization Of Marrow Space
 - Sensitivity 100% ; Specificity 60%-70%
 - Limits With Internal Fixation



Fracture Related Infections Nuclear Medicine Scans

Nuclear Medicine Scans

- Classic Bone Scan: High
 - Sensitivity, Low Specificity

Technetium ⁹⁹ WBC Scan:

Replaced Indium, Better Imaging



Fracture Related Infections Microbiology

- Classic Culture Techniques
 - Changed Little In Past 100 Yrs
 - Contamination —> False +'s
 - Inadequate Sample Size
 - Incorrect Agar Composition
 - Inadequate Incubation Time



Fracture Related Infections Cultures

- Classic Culture Techniques
 - Lack Sensitivity
 - Lack Accuracy
 - Takes Too Long In Sick Pts
 - Special Problems; ie TB
 - False Negatives Biofilms



Fracture Related Infections Cultures

- Hold Antibiotics Before Cultures
- Multiple (5-6) Deep Cultures
- Disrupt Biofilm
- Appropriate Enrichment Medium
- Sufficient Duration 10-14 Days
- Full Antibiotic Sensitivty Report



Fracture Related Infections Biofilm

Biofilm Bacteria Produce An Extra-

Cellular Matrix That Provides A

Protective Coating Allowing The

Bacteria To Undergo A

Metamorphosis Into A Multi-Cellular

Organism That Provides For Its

Survival As An Adherent Form



Fracture Related Infections Biofilm

Within This Structure,
 Microbes Are Resistant To
 Antibodies, WBCs, And
 Antibiotics !

Orthopedic Implants Serve
 As Inert Surface For The
 Propagation Of Biofilms



Fracture Related Infections Newer Technologies

- Molecular Diagnostics (MDx)
- Polymerase Chain Reaction
- DNA Sequencing Techniques
- Sonication
- Genomic Sequencing
- Still Relatively Expensive



Fracture Related Infections Treatment

- Irrigation & Debridement
- Excision Necrotic & Poorly
 Vascularized Tissue
- Determine Implant Stability
- Multiple Cultures
- Manage Dead Space
- Negative Pressure Dressings



Fracture Related Infection Paradox Of Infection & Implants

- Retention May Perpetuate Infection
 - 2^o To Foreign Body Effect
 - Biofilm Shielding
- Removal Of The Implant
 - Destabilizes The Fracture
 - Instability Perpetuates Infection



Fracture Related Infection Antibiotic Carriers

- Most Common Antibiotics
 - **Delivered By Carriers**
 - Gentamycin, Tobramycin, Vanco
- Autograft: Scaffolding & Biologic
- PMMA: Most Commonly Used
- Ceramics: Osteoset T ; Cerament
 - CaSO4
 - CaPhos



Fracture Related Infections Polymethyl Methacrylate (PMMA)

- Most Commonly Used Carrier
- Heat Stable Antibiotics
- High Local Doses
- Block Spacers or Beads
- Antibiotic PMMA "Nail"
- Large Body Of Literature



Fracture Related Infection Stable Hardware

- Management Of Wound
 - Closure Over Drain
 - Bead Pouch; PMMA Spacer; Wound Vac
 - IV Antibiotics
 - Soft Tissue Reconstruction
 - Rotational Flap
 - Free Tissue Transfer



Fracture Related Infection Unstable Hardware

- HWR & External Fixation
- Antibiotic Spacers / Nail
- Culture Specific Antibiotics
- Soft Tissue Reconstruction
- Staged Reconstruction
- Bone Grafts



Fracture Related Infection Conclusions

- Infection In Fracture Surgery Is Inevitable
- Aggressive Treatment
 - Antibiotics
 - Surgical Debridement
 - Soft Tissue Management
- Fracture Stability Essential
- Staged Reconstruction



It Is Not Enough To Stare Up The Steps; We Must Step Up The Stairs



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