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
Definition

• 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

Injury 49 (2018) 505-510


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
  2. Purulent Drainage From the Wound Or Presence of Pus Identified at Surgery
  3. 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
- It's 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

7 Weeks Post-Op Draining & Failing
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
  - $2^\circ$ 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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