

New Materials in Fixation

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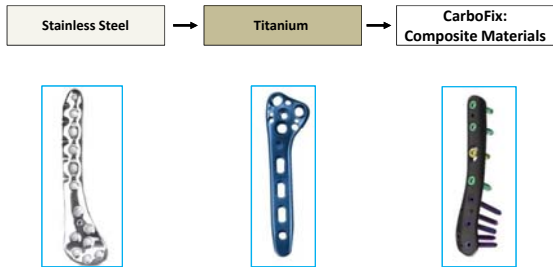
- Disclosures**
- Consultant
 - Acumed, **CarboFix**, Citieffe
 - Editorial Board
 - Journal of Orthopaedic Surgery and Research
 - Trauma Cases and reviews
 - Royalty
 - Citieffe
 - Speakers Bureau
 - Acumed
 - Stock Options
 - **CarboFix**
 - Some of the slides courtesy of Bruce Ziran, MD

- Objectives**
- Discuss new materials in internal fixation
 - Discuss future directions

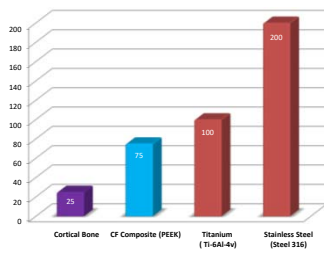
Internal Fixation

- Carbon Fiber
- Bioabsorbable materials

Evolution – Improved Modulus




Modulus of Elasticity




Potential Effect on Healing

- Lower modulus may enhance callus formation
- “Bone-phillic”


Immediate Post-OP



2 Weeks Post-OP





4 Weeks Post-OP



Carbon Fiber Reinforced (CFR) PEEK

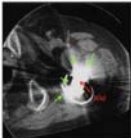
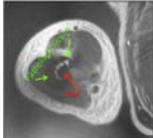

- CFR PEEK biocompatibility: USA guidelines
- Clinical experience/safety of CFR PEEK > 10 yrs





Why carbon fiber? Problems with metal

- High elastic modulus compared to bone
- Radiopaque (can't see through X-rays)
- Artifacts with CT & MRI
- Potential allergic response
- Potential barometric symptoms
- Cold welding with Ti

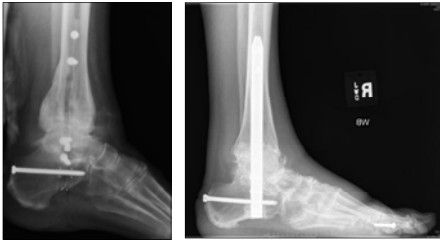
Fatigue Properties

- Can withstand > 1,000,000 cycles without failure or damage



Radiolucency

- Better evaluation of healing

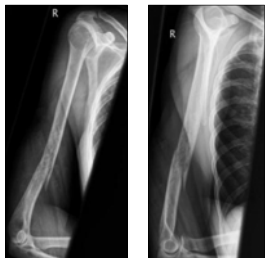




Radiolucency

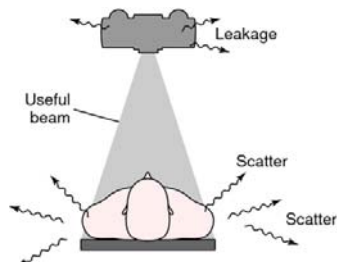
- Better evaluation oncologic lesion

- 51yo F
- Breast Ca
- Path fracture



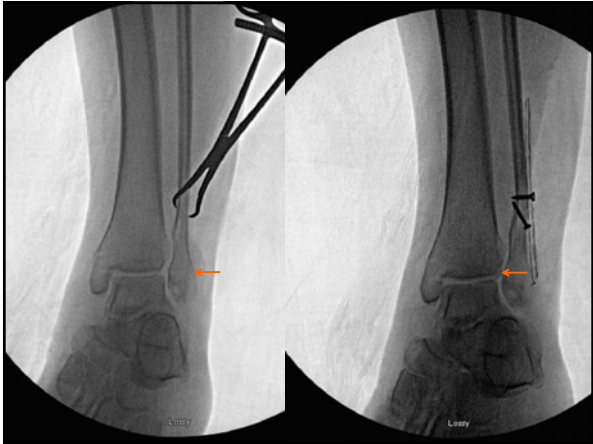
Radiolucency – advantage in CA

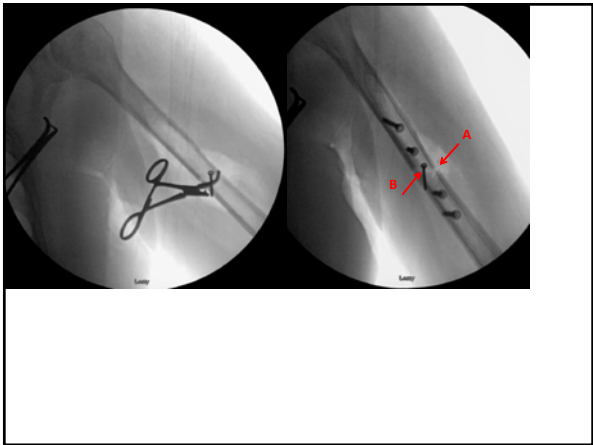
- Less scatter for XRT

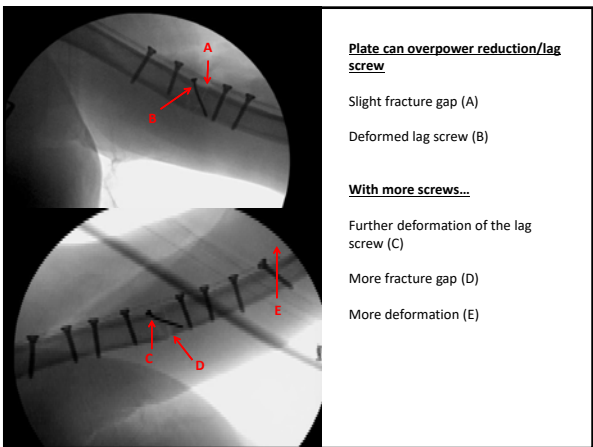


Limitations

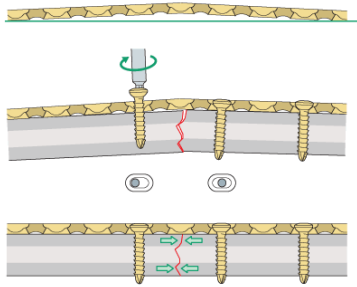
- Interlocking holes (perfect circles) are challenging
 - Can enhance with changing kVP and mA
- Plates are not bendable
 - Can “over-reduce”
 - Plates can crack
- “Can’t hide”
- Wear debris?



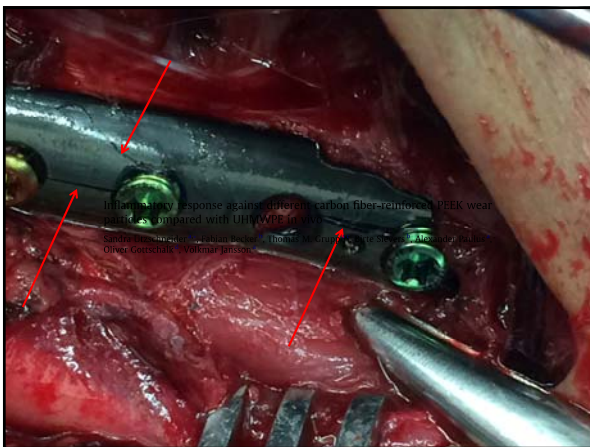




Potential problems with compression







Wear debris?

- **Inflammatory reaction similar between CFR-PEEK and UHMWPE**
 - CFR-PEEK superior mechanically and chemically

Bioabsorbable materials

- Impetus: ORIF with “absorbable rods”
 - Pediatrics
 - Arthrodesis
 - Metal-sensitive areas
 - Prominence
 - Radiolucent



Materials available

- PGA – poly-glycolic acid
- PLA – poly-lactic acid
- PDS – poly-dioxanone
- PLLA – poly-levo-lactic acid

- PLLA – slowest degradation, least reactive

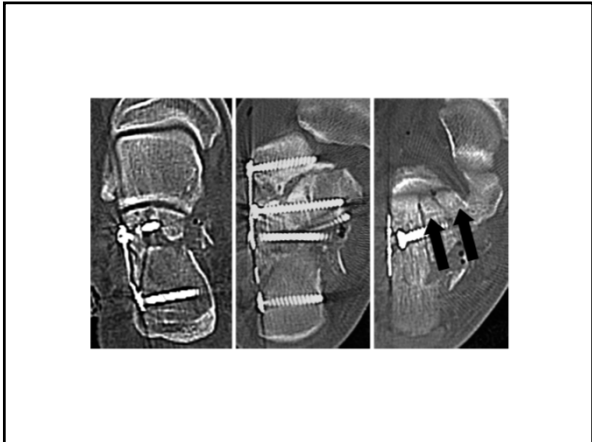
Advantages

- Radiolucency and lack of artifact
- Lack of "stress shielding"
- Biodegradable
- Gradual load transfer
- No need for ROH

Applications

- Femoral head fractures
- Various pediatric applications
- Challenging articular fractures





Limitations

- Not contourable
- Poor shear tolerance (after 5 weeks)
- Subject to creep and stress-relaxation
 - Compressive screws lose 20% within 20 minutes
- Reactivity
 - Aseptic inflammation
 - Sinus tract formation
 - Osteolysis
 - Synovitis

Limitations

- Bioabsorbable, but not osteoconductive
 - Debris is typically left behind (inert)
 - Reaction (Walton, J Biomater Appl 2007):
 - Sequestration first 3 months
 - Inactivity until 1 year
 - Gradual disintegration and fragmentation 1-3 years
 - NOT replaced by bone

Future direction

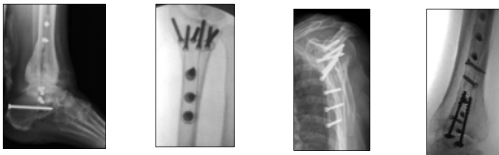
- Bioabsorbable materials that permit
 - Osteoinduction
 - Osteoconduction
 - Osteogenesis
- Able to modulate cellular signals at molecular level
- Able to modulate mechanotransduction

Current avenues

- Tissue engineering and scaffold development
 - Problems
 - Angiogenesis
 - Cellular longevity
 - Delivery
 - Development focused primarily for spinal and arthroplasty options

Summary

- Alternative implants both possess strengths and weaknesses
- Radiolucency and ability to evaluate for healing
- Reactivity and strength profile differ
- Next generation: molecular and cellular level



Thank you