Fracture Fixation Augmentation: Techniques and Best Materials

R. Trigg McClellan, MD

Clinical Professor Emeritus
University of California San Francisco

May 24 – May 27 2023
San Francisco, Ca

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Disclosures

- Biologica Technologies, LLC
- Dimensional Bioceramics, LLC
- EPIX Orthopaedics

Background

Bone augmentation with biomaterials was first described in 1984

Deramond injected polymethyl methacrylate cement into a cervical vertebral body to treat a painful intravertebral haemangioma

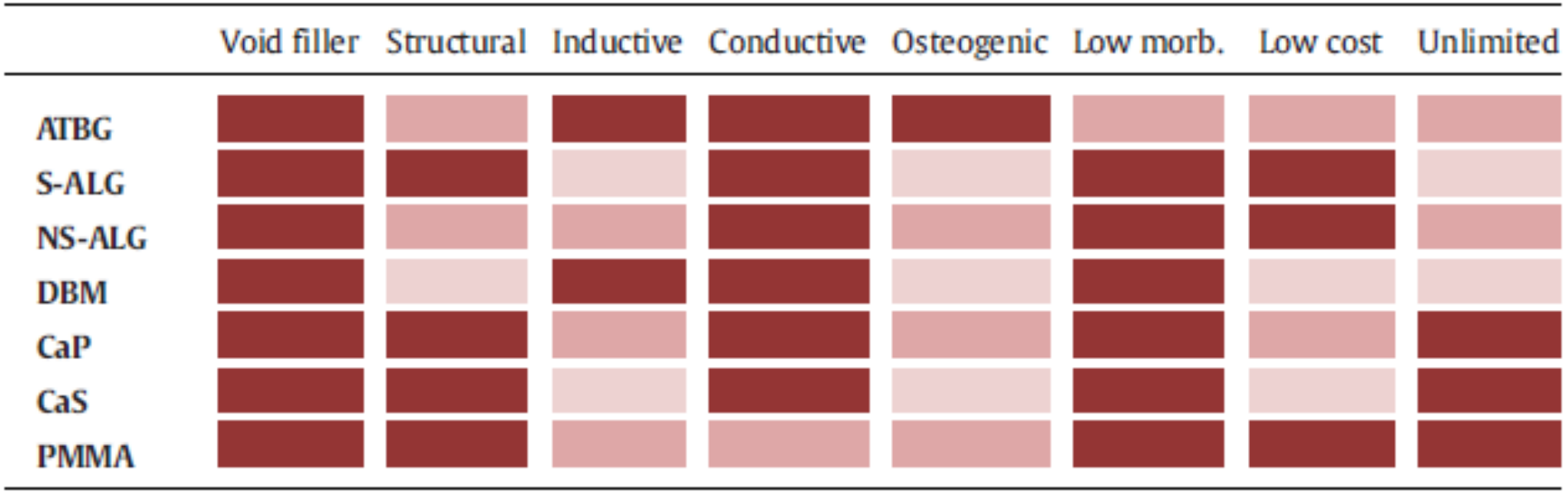
Challenges

Advances in implant design such as locked plates

Still need to promote fracture biology, augment bone defects, and improve surgical fixation in the osteoporotic patient

Ideal material

Table 1.
Characteristics of bone augmentation materials.



ATBG = autologus bone graft, S-ALG = Structural Allograft, NS-ALG = Non Structural Allograft, DBM = Demineralized Bone Matrix, CaP = Calcium Phosphate, CaS = Calcium Sulfate, PMMA = Polymethylmethacrylate. Dark Pink = Strongly Advantageous; Salmon = Weakly Advantageous; Light Pink = Not Advantageous.

Current treatment options for critical size bone defects

- “Gold Standard” autograft
- Allograft
- Synthetic bone graft substitutes
- Vascularized fibular graft
- Induced membrane technique
- Distraction osteogenesis

The major impediment to bone healing with current treatment options

Insufficient vascularization and incorporation of graft material

Induced membrane technique – Masquelet

- Two-stage procedure with temporary cement spacer is introduced into a bone defect and is later removed and replaced by autograft and possible allograft adjunct
- Over a period of weeks, the cement induces a foreign body reaction that leads to formation of a fibrous, vascular membrane around the spacer

CN

75 y/o RHD Female

Parkinson's Disease

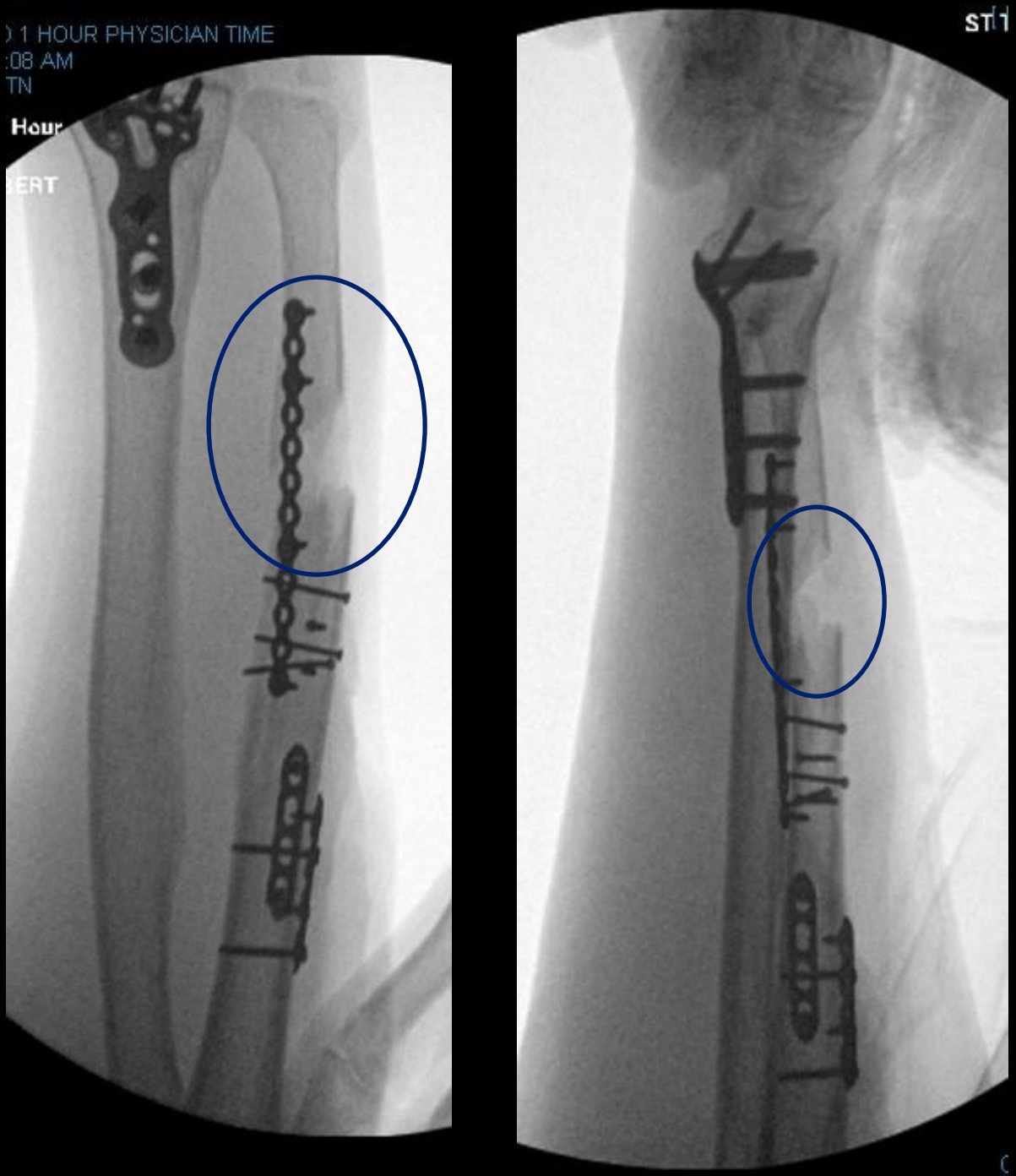
Orthopaedic Trauma Institute

UCSF + SAN FRANCISCO GENERAL HOSPITAL

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

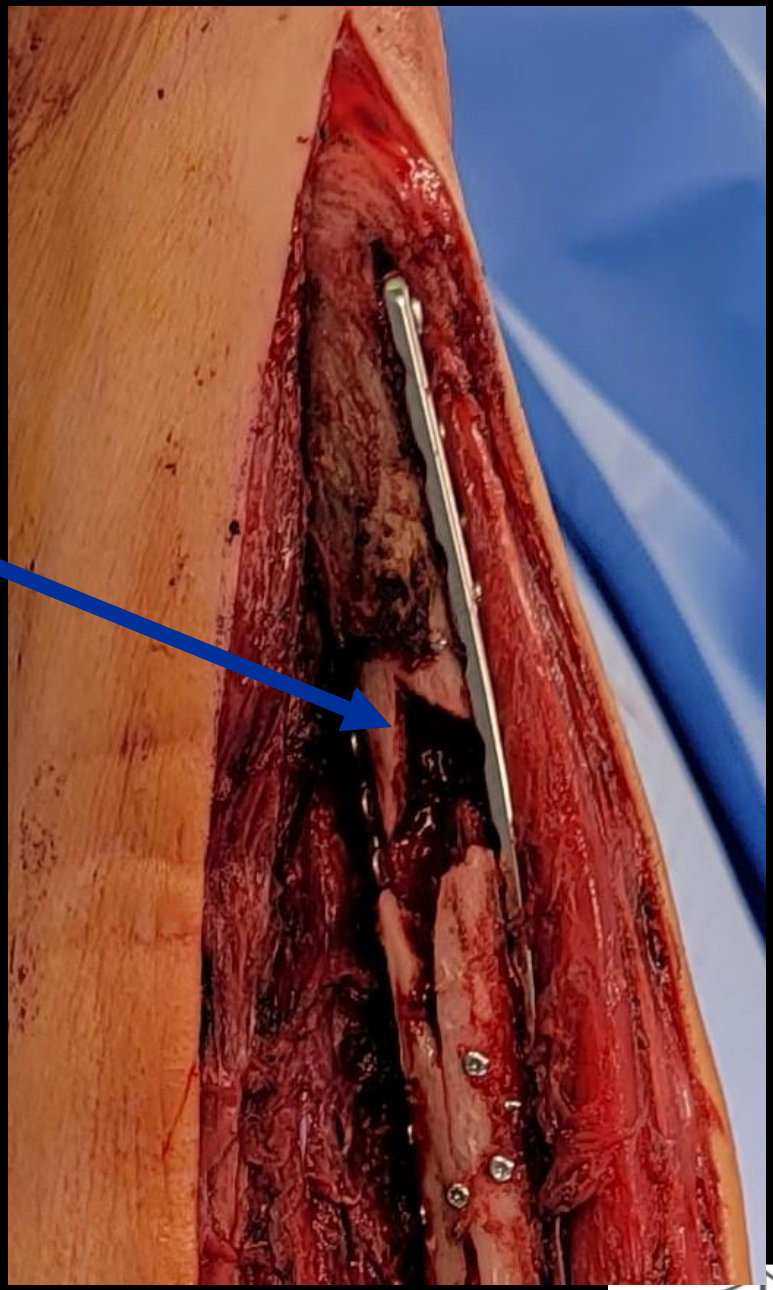
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

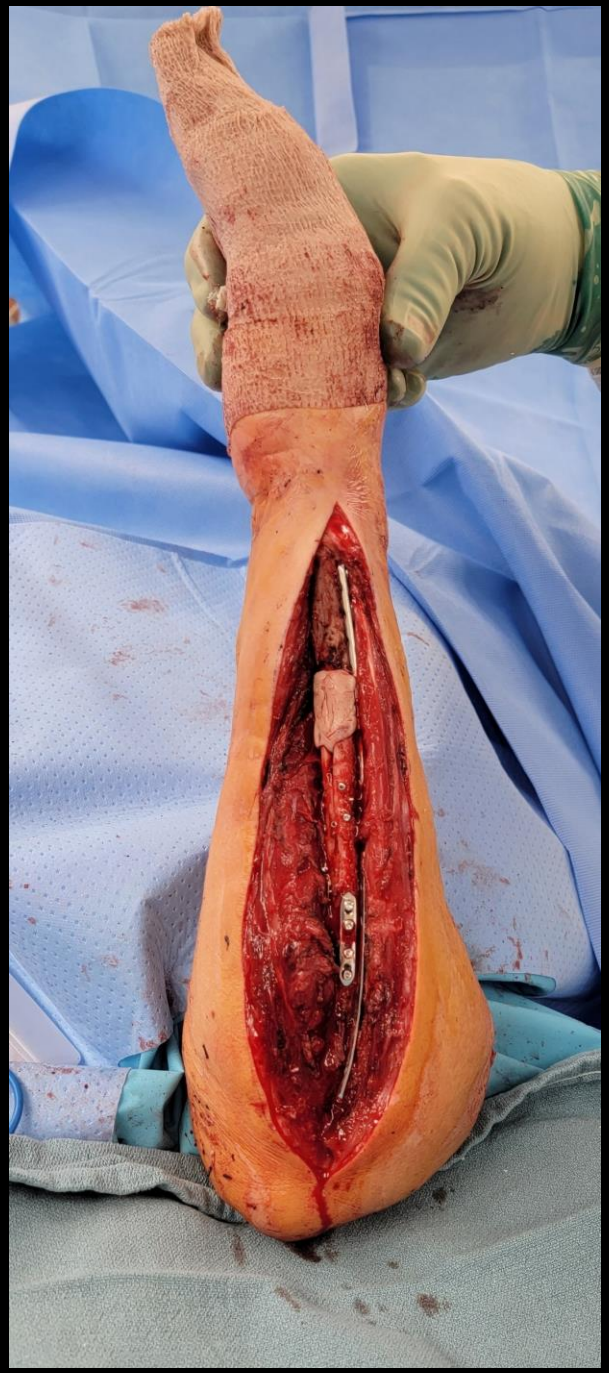
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

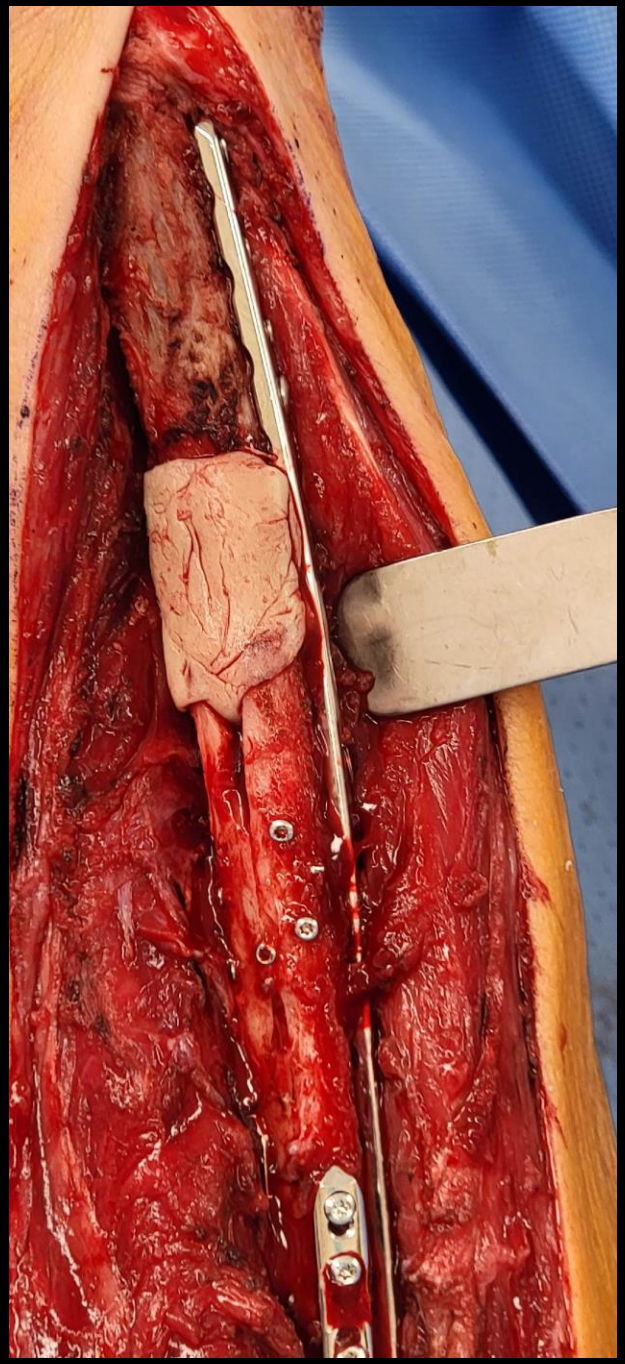


Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Defect

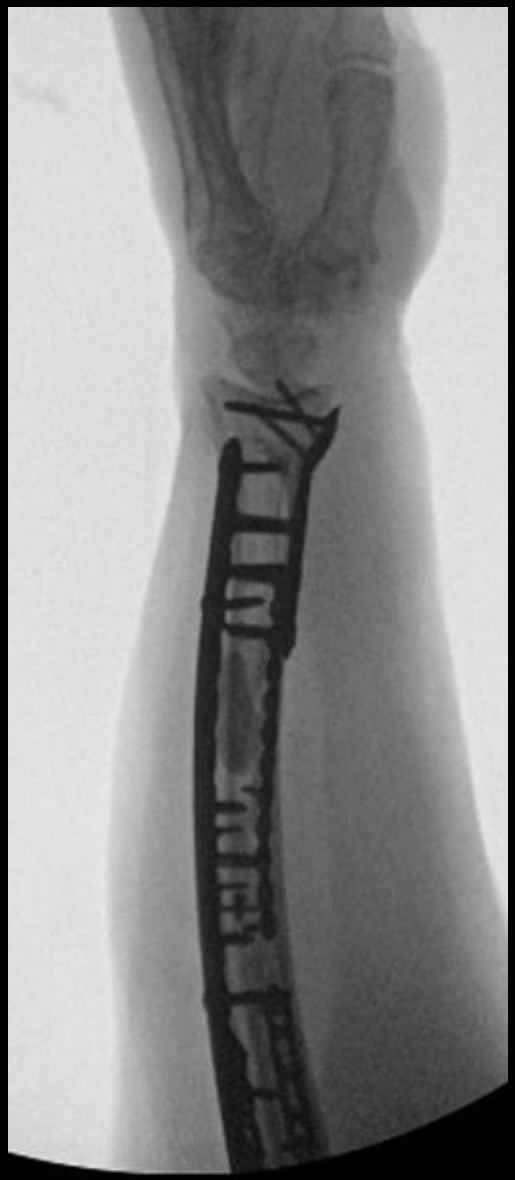






Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL





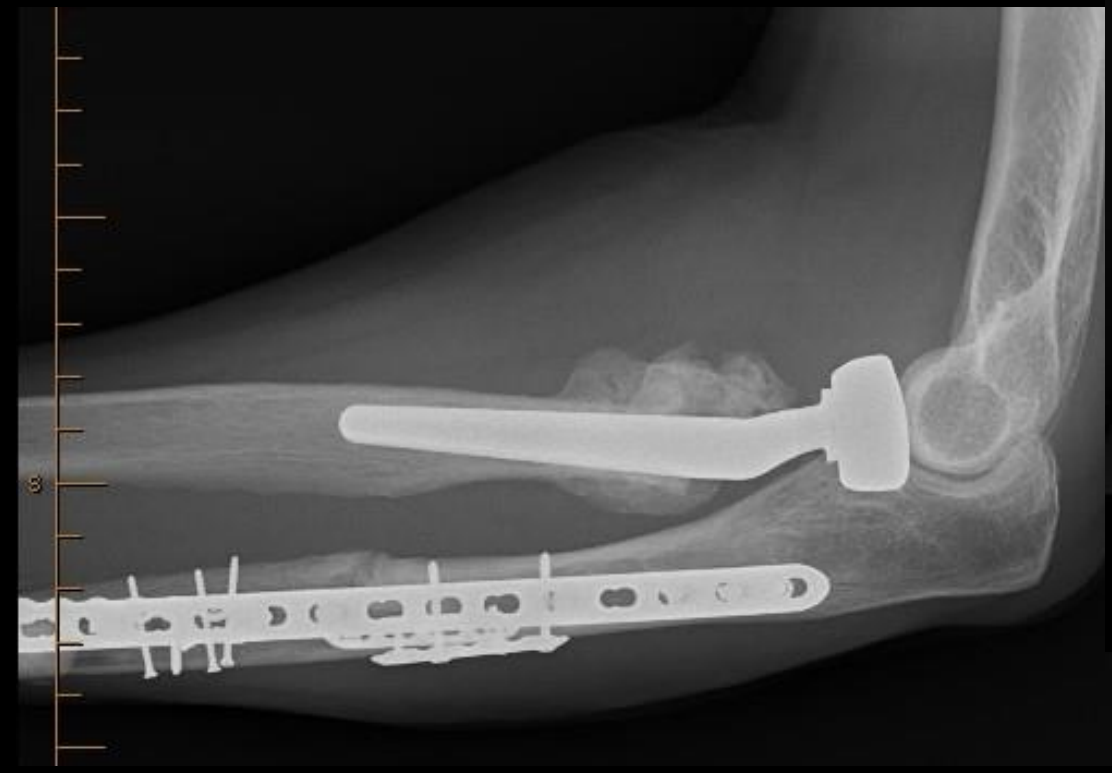
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

4 mon po

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

4 MON PO

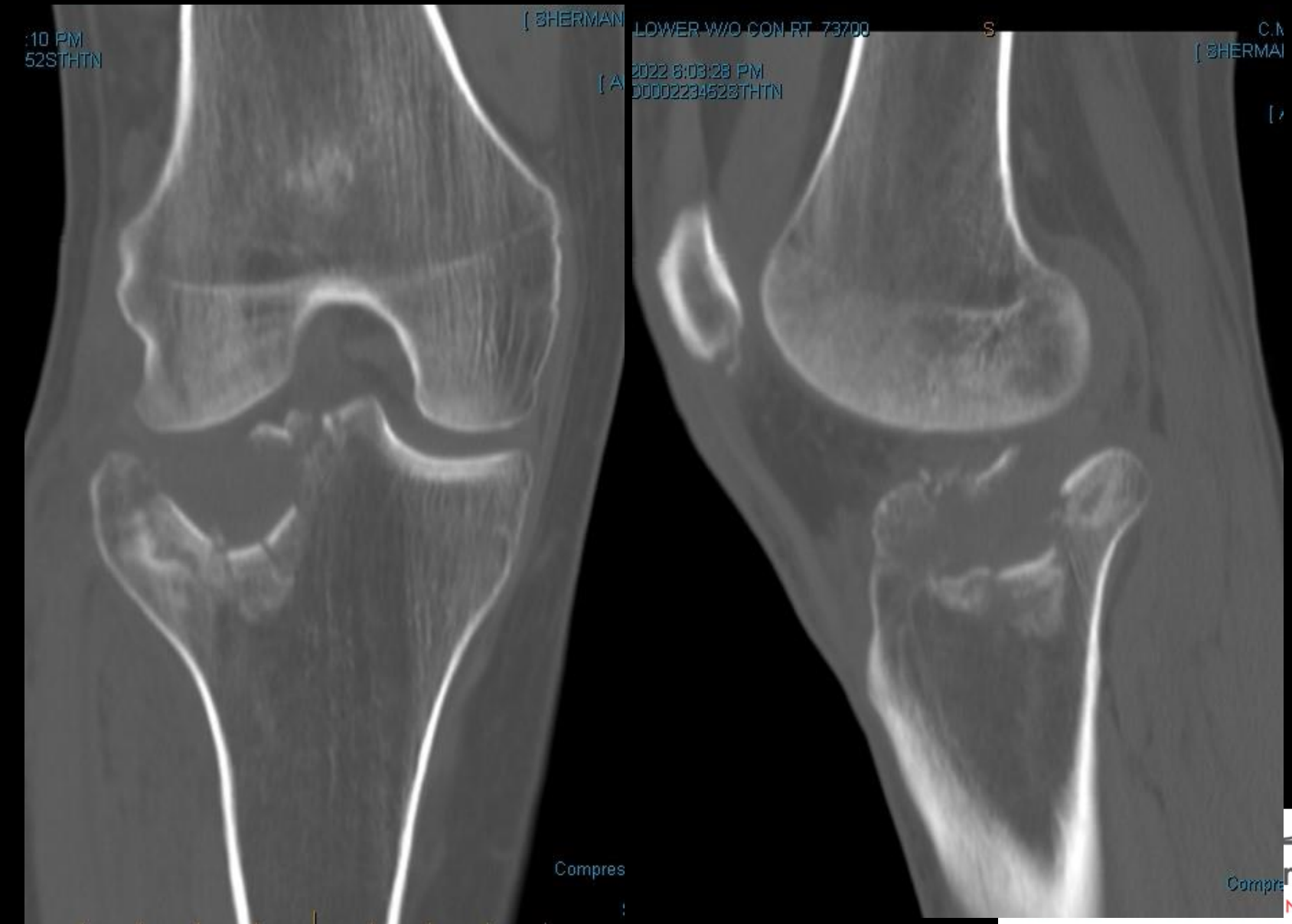


Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Calcium Phosphate Cement

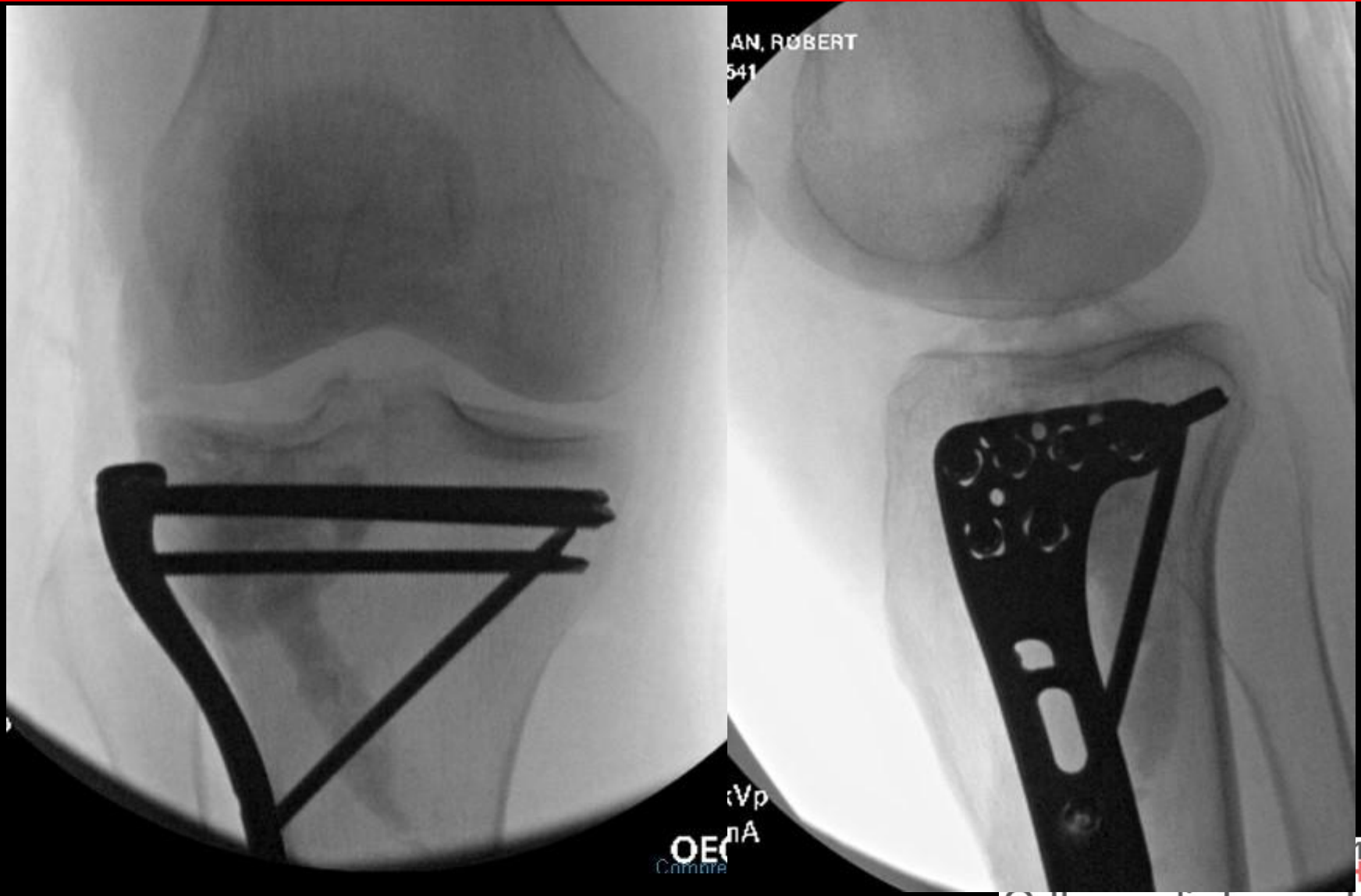
Endosteal implant

NS 60 y/o



ma Institute
NERAL HOSPITAL

CaP injection



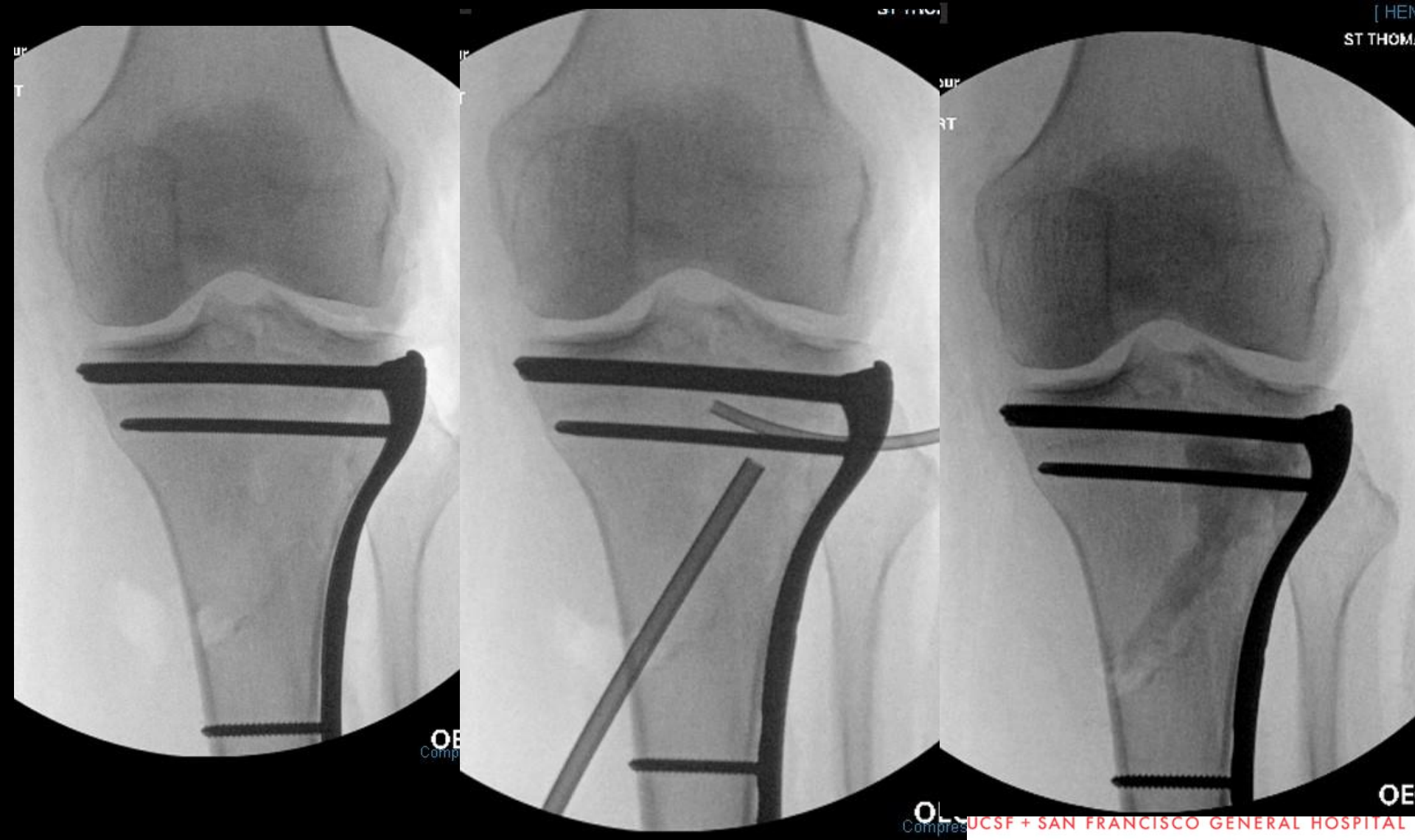
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

NS post op

BH 42 y/o

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

BH intra-op



BH post op

Future

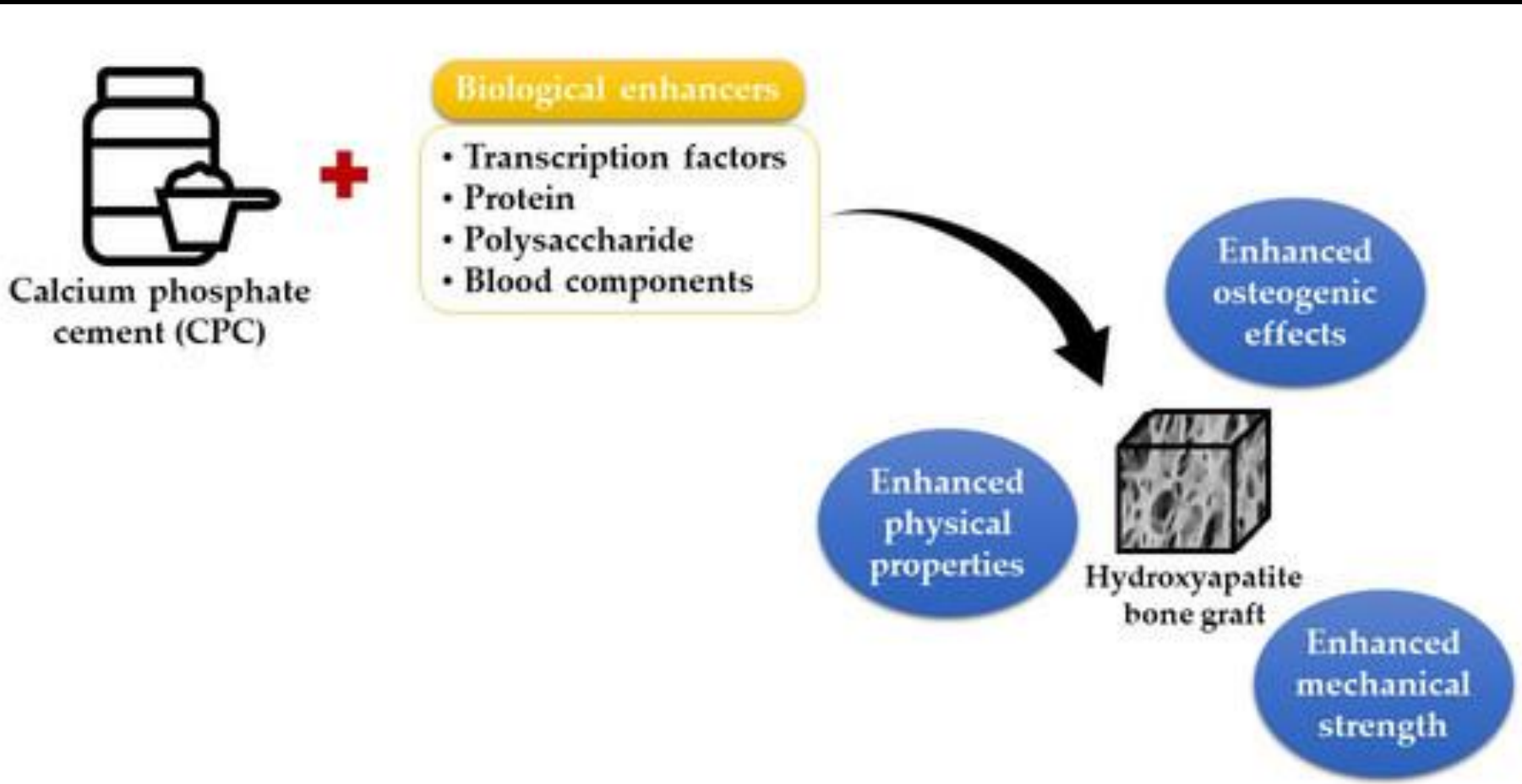
Challenge remains to be the development of anatomically-shaped, bioactive, mechanically strong and tough scaffolds required for the reconstruction of load-bearing large bone defects.

Advances in the 3D Printing

- The mechanical properties of recently 3D printed bioceramic and bioglass scaffolds with ~ 50% porosity have reached those of cortical bone in terms of stiffness and strength

- However, their toughness (resistance to propagating cracks) is yet to be optimized.

Calcium Phosphate Cements




Thank You