

# Bone Graft & Bone Graft Substitutes

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## The Ideal Bone Graft

- ▶ Osteoconduction, induction and production
- ▶ No risk of immunogenic rejection or infection transmission
- ▶ Gradual incorporation into host bone through substitution
- ▶ Well molded into defect in short time
- ▶ Thermally non-conductive, sterilizable, readily available
- ▶ Reasonable cost
  - ▶ Of the >5 000 000 MSK procedures/year in the US, nearly 1/3 utilize bone graft

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## Autograft

- ▶ Iliac crest
  - gold standard for augmentation; quick to harvest, reliable
  - open structure promotes rapid revascularization and can expect survival of numerous graft cells
  - 5mm graft can be totally revascularized in 20-25 days
- ▶ Vascularized Fibula
  - good option for large diaphyseal/structural defects, previously infected sites

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## Autograft

- ▶ Reamer/Irrigator/Aspirator (RIA)
  - capable of harvesting up to 80 ml.
  - high levels of osteoinductive growth factors
  - Complications 20% - cortical or articular perforation, eccentric reaming, fracture

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## Allograft

- ▶ - like free autograft, requires revascularization in a stable environment and vascular bed
- ▶ Pro
  - Minimal risk of disease transmission
  - only 2 reported cases of HIV infection (1:1.6 million) and rare HBV and HCV
  - Used for mechanical support
- ▶ Con
  - lost osteoinduction and production through freeze drying
  - Concern regarding mechanical properties

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## Demineralized Bone Matrix (DBM)

- ▶ acid extraction of mineralized extracellular matrix of allograft bone
- ▶ contains Type-1 collagen, noncollagenous proteins, & osteoinductive growth factors
- ▶ Highly osteoconductive due to its particulate nature
- ▶ available in freeze-dried powder, granules, gel, putty and strips
- ▶ can be combined with allograft chips & CaSO<sub>4</sub> granules
- ▶ some evidence to support efficacy of DBM compared to autograft but potency is variable by manufacturer and further study is needed
- ▶ Common brands include Accell, AlloFuse, Allomatrix, Grafton DBM, Integro DBM, Magnifuse, Optefill, Origen DBM, OsteoSelect, Progenix

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## Ostoconductive graft substitutes

- ▶ graft mimics cancellous bone to facilitate migration, attachment & proliferation of host progenitor cells
- ▶ most are calcium ceramics – Ca sulfate, Ca phosphate, tricalcium phosphate, beta tricalcium phosphane & coralline hydroxyapatite
- ▶ osteointegration through chemical dissolution and creeping substitution
- ▶ osteoinductive factors sometimes added to increase bone formation
- ▶ Case series raised concern regarding GeneX (tricalcium phosphate & calcium sulphate) causing a high incidence of aseptic inflammation and delayed wound healing

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## Bioactive Glass

- ▶ Not "window" glass
- ▶ reactive to extracellular fluids and bonds to bone and promotes new bone growth.
- ▶ over time, glass dissolved completely and is replaced by bone
- ▶ Examples: Interface, Novabone

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## Patient-derived cellular therapies

- ▶ Harvested progenitor cells from bone marrow or other tissues combined with bioactive scaffold matrix
- ▶ Concentrating marrow elements into an osteoconductive substrate with a microporous structure provides a more stable environment for cell growth than use of marrow aspirates alone.
- ▶ Excellent results (comparable to autogenous ICBG) when aspiration and concentration methods and composite grafting techniques are well controlled.
- ▶ Osteoecel Plus, Trinity Evolution

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## Platelet-rich plasma (PRP) & Growth Factors

- ▶ alpha granules in platelets contain >30 bioactive proteins with roles in hemostasis and/or tissue healing
  - platelet-derived growth factor (PDGF)
  - transforming growth factor-beta (TGF-β)
  - vascular endothelial growth factor
  - epidermal growth factor
  - platelet-derived endothelial growth factor
  - insulin-like growth factor
  - fibrinogen
- ▶ And many others
- ▶ Mostly anecdotal studies are available. Inconclusive role in bone augmentation
- ▶ Recombinant human PDGF in CaPO<sub>4</sub> matrix has been shown to improve effects of diabetes on fracture healing by promoting early cellular proliferation and bone formation.

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## Inductive substrates

- ▶ BMP's are part of TGF-β superfamily of growth factors
- ▶ induce undifferentiated progenitor cells (stem cells) into osteoprogenitor cells.

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## Xenograft-derived bone scaffold

- ▶ Decellularized porcine cancellous bone has been tested as a biocompatible, pathogen-free, osteoconductive and potentially osteoinductive material for bone defects

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