Graft Options

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Disclosures
None

Options
- Autograft - patients own bone or harvested components
- Allograft - cadaveric donor bone
- Demineralized Bone Matrix - allograft cortical bone with calcium and phosphate removed leaving behind BMPs added to a carrier
- Ceramics - engineered materials that mimic some bone properties
- Bone Morphogenetic Protein - growth factor that induces cellular proliferation and transforms connective tissue into osteoprogenitor cells
- Bone Marrow Aspirate - concentrated marrow cells

Bone Graft Properties

- Osteogenesis - contain cells that form bone or precursors
- Osteoinduction - contain agents that recruit or differentiate cells to the fusion site
- Osteoconduction - Scaffold for fusion

<table>
<thead>
<tr>
<th>Graft Type</th>
<th>Osteo-genesis</th>
<th>Osteo-conductive</th>
<th>Osteo-inductive</th>
<th>Fusion Rate %</th>
<th>Cost</th>
<th>Comments / Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autograft Bone</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>74-100</td>
<td>Minimal</td>
<td>Donor Site</td>
</tr>
<tr>
<td>Autograft Marrow</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>97 (bone)</td>
<td>Need Carrier/Cage</td>
<td></td>
</tr>
<tr>
<td>Allograft</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>54-100</td>
<td>Donor availability / screening</td>
<td></td>
</tr>
<tr>
<td>DBM</td>
<td>-</td>
<td>+/-</td>
<td>+</td>
<td>60-97</td>
<td>Variable bioactivity</td>
<td></td>
</tr>
<tr>
<td>Ceramics</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>78-100</td>
<td>+</td>
<td>Need cage</td>
</tr>
<tr>
<td>BMP</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>97-100</td>
<td>+++(alone) +++(cage)</td>
<td>Complications</td>
</tr>
</tbody>
</table>

http://doi.org/10.1007/s00586-008-0878-4

Autograft

- Iliac Crest, Rib
- "Gold Standard"
- OG, OC, OI and structurally supportive
- "Free"
- Nothing is free
  - New blood risk
  - Painful - Autograft site
  - Graft site infection, hematomas etc.
Bone Marrow Aspirate

- Mesenchymal Stem Cells (OG, OI)
- "Free"
- Effective dose unknown
- Iliac crest or vertebral body
- 2mL max per site (avoid dilution)
- Negatives:
  - Not free: Still need a carrier and a cage ($$)
  - Poorly studied

Allograft

DC, OI (+/-), structural
No Donor site morbidity

Preparation:
- Frozen (strongest)
- Freeze-Dried (strong)
- Gamma-irradiated (weak)

Pre-Fabricated
- Cortical (structure)
- Cancellous (DC, OI)

Not available for donors (culture dependent)

Unsafe if poor screening

Not well studied vs. autograft (No high quality RCTs)

Fibula for corpectomy, pack morsellized autograft in and around

Demineralized Bone Matrix

- Allograft cartilage and bone with calcium and phosphate removed via acid extraction
- Added to carrier
  - Glycerol
  - Poloxamer
  - Lecithin
  - Hyaluronic acid
  - Gelatin
  - Calcium sulfate

- Active ingredients: BMPs
- Many different forms
- Fusion 60-97%
- Need cage for structure
- Significant intra and interproduct variability in BMPs*

Demineralized Bone Matrix Studies

Ceramics

- Osteoconductive
- Crystalline structures of inorganic, non-metallic mineral salts
- Micro and macroporosity effect osteoconductivity
- Calcium phosphate
  - Biphasic Calcium phosphate (combines both HA and β-TCP)
  - Hydroxyapatite (prevents remodeling)
  - Beta-tricalcium phosphate (resorbs rapidly)
- Calcium carbonate
- Coralline HA

Ceramic Bone Fusion 78-100%
Needs cage

Recombinant BMP-2

- Growth factor that induces cellular differentiation to connective tissue into osteoconductive bone
- Highly osteoinductive
- Fusion rate 97-100%
- Complex algin (thought to be dose dependent)
  - Seroma
  - Ectopic bone formation
  - Dysphagia in anterior spine
- FDA black box warning against use in anterior cervical spine
- High cost
  - Needs structural support

Soft Tissue Swelling


Notable BMP Studies


Low dose per level 0.6mg
100% fusion
2% reoperations for hematoma or seroma

Does rhBMP-2 show better fusion rates?
Cages

- Titanium
- PEEK
- Carbon fiber

So what should I do?

Techniques for cervical interbody grafting

- Autograft, Allograft or Titanium Cage
  - Evidence: Class II, strength of recommendation C
- PEEK Cages, Carbon fiber cages, rhBMP-2
  - Evidence Class III, recommendation B

Cost Effectiveness

<table>
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<tr>
<th>Biological Substitutes/Extenders for Spinal Arthrodesis</th>
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<td>Which Agents Are CostEffective?</td>
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<td>Welington K. Hui, MD* Robin E. Hambright, PhD†</td>
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Cost Effectiveness

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Mixed data and results depending on the study and costs included. Some studies suggest a cost benefit to BMP-2 if societal costs and rapid return to work is included.