NEW FIXATION STRATEGIES FOR OSTEOPOROTIC BONE
THE PROBLEMS

Fixation failure

Malunion

F 83 yrs 2 Months 6 Months F 81 yrs 3 Months
FIXATION AUGMENTATION TECHNIQUES (FATs)

• Surgical procedures aimed at increasing fixation stability

• Should be considered when treating osteoporotic fractures

• In joint reconstruction in severely osteoporotic bone (shown by pre-operative DXA)
CLASSIFICATION

- Polymethylmethacrylate (PMMA: acrylic bone cement)
- Bone grafts
- Bone graft substitutes (calcium phosphate)
- Modified implants
- Pharmaceuticals
- Combined FATs

Polymethylmethacrylate Augmentation of Pedicle Screw for Osteoporotic Bone Spinal Surgery

A Novel Technique

Ming-Chau Chang, MD, Chien Lin Liu, MD and Tain-Hisung Chen, MD

“Safe reliable and practical technique for osteoporotic patients”
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<th>PMMA</th>
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<td>- Time-consuming</td>
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<td>- Costly</td>
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<td>- Excessive heating during polymerisation leading to bone necrosis</td>
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<td>- Difficult to remove if revision surgery is required</td>
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BONE GRAFTS

- Autografts
- Allografts
BONE GRAFTS

AUTOGRRAFTS

• Enhance osteogenic response
• Have osteoinductive and osteoconductive potential
• Structural support to maintain fracture reduction
• Generally harvested from patient’s iliac crest
• Finite quantity available
• Donor-site morbidity
BONE GRAFTS
ALLOGRAFTS

• No osteogenic potential
• Mechanically improve fracture stability
• No donor-site morbidity
• Possible disease transmission
BONE GRAFT SUBSTITUTES

- Synthetic materials that possess osteoconductive and structural properties
- Do not possess osteoinductive or osteogenic potential
BONE GRAFT SUBSTITUTES
CALCIUM PHOSPHATES

• Calcium phosphates account for most ceramic-based bone graft substitutes
• Close chemical and crystal resemblance to bone mineral
• Biocompatible
• Scaffolds that induce a biologic response similar to bone
• The most widely used form of calcium phosphate is hydroxyapatite (HA)
BONE GRAFT SUBSTITUTE
CALCIUM PHOSPHATE GRANULES

• Several FDA approved products
• Mixtures of high and low crystallinity hydroxyapatites
• Good osteointegration with host bone
• Low mechanical strength
• Slow resorption
• Paucity of comparative studies with autografts
• Objective data showing direct comparisons are virtually nonexistent
Injectable
Non-exothermic reaction upon setting
Structural support
Higher compressive strength than cancellous bone
Good bone penetration
No morbidity
No adverse biological effects
Calcium phosphate cement for augmentation did not improve results after internal fixation of displaced femoral neck fractures: A randomized study of 118 patients
Per Mattsson and Sune Larsson

Department of Orthopedics, Uppsala University Hospital, SE-751 85, Uppsala, Sweden
Acta Orthopaedica
Volume 77, Number 02/April 2006, 251-256

• 118 FN fractures, 24 month follow-up
• No difference in pain or muscle strength
• Trend towards more reoperations in augmented group due to loss of reduction, nonunion or avascular necrosis
• “...augmentation cannot be recommended”

Level I Evidence (JBJS Classification)
BONE GRAFT SUBSTITUTES
CALCIUM PHOSPHATE CEMENTS

BURNING ISSUES

- Remodeling capacity?
- Long-term resorption?
- Mechanical resistance to shear stress?

3 months  5 years
BONE GRAFT SUBSTITUTES
CALCIUM PHOSPHATE COATINGS

• Well bound to metal implants
• Increase osteointegrative ability of screws
• Increase fixation

HA-coated external fixation pin
HA-coated AO/ASIF cortical bone screw
HA-coated AO/ASIF cancellous bone screw
BONE GRAFT SUBSTITUTES
CALCIUM PHOSPHATE COATINGS

STANDARD AO/ASIF SCREW

HA-COATED AO/ASIF SCREW

Moroni et al, J Orthop Trauma, 2002
**Improvement of the Bone-Pin Interface Strength in Osteoporotic Bone with Use of Hydroxyapatite-Coated Tapered External-Fixation Pins**

*Level I Evidence (JBJS Classification)*

- Better fixation
- No pin-tract infection
HA-coated Screws Decrease the Incidence of Fixation Failure in Osteoporotic Trochanteric Fractures

Antonio Moroni, MD; Cesare Faldini, MD; Francesco Pegreffi, MD; and Sandro Giannini, MD

- 4 cut-outs in the standard lag screws
- No cut-out in HA-coated lag screws
- Better clinical outcomes in HA-coated group

Level I Evidence (JBJS Classification)
MODIFIED IMPLANTS

WHY DO WE NEED MODIFIED IMPLANTS?

- All available implants designed for fixation of normal bone
- No implants specifically designed for fixation of osteoporotic bone
- Traditional implants do not perform optimally in osteoporotic bone
MODIFIED IMPLANTS
CHANGES IN SCREW DESIGN

Screw holding power increased using screws with:

- Smaller pitch
- Greater screw thread angle
- Smaller core diameter
MODIFIED IMPLANTS
INTERLOCKING SCREWS

• 100% increase in holding strength compared to standard screws
• No clinical data

MODIFIED IMPLANTS
EXPANDABLE SCREWS

- Cylinder inserted into screw shaft which then expands
- 50% greater holding power than standard screws
- No clinical data to convalidate the study

MODIFIED IMPLANTS
CANNULATED PORTED SCREWS

- No implant failure in 63 osteoporotic fractures fixed with plate and ported screws

PHARMACEUTICALS
BISPHOSPHONATES

• Zolendronic Acid, Ibandronate, Alendronate
• Systemic and local administration
• Animal studies consistently showed improved screw fixation/osteointegration at an early stage

Skoglund et al, JOR, 2004
Bobyn et al, JBJS (Br), 2005
Miyaji et al, CORR, 2005
Peter et al, JBMR (Part A), 2006
Conclusions “Weekly post-op systemic administration of alendronate for 3 months improves pin fixation in cancellous bone in elderly female patients with osteoporosis.”
Conclusions “PTH increased the mean screw removal torque from 1.1 to 3.5 Ncm (p= 0.001)”
COMBINED FATs
LCP AUGMENTED WITH HA-COATED SCREWS

Fixation of HA-Coated Unicortical Locking Screws in a Sheep Gap Model: A Comparative Biomechanical Study

Antonio Moroni, MD,* Francesco Pegrelli, MD,* Amy Hoang-Kim, BScH,* Federico Tesei, MD,* Sandro Giannini, MD,* and Burkhardt Wippermann, MD†

5-fold greater fixation
Better gap healing
COMBINED FATs

- Cements loaded with osteoinductive growth factors, cells and drugs
- Coated fracture fixation implants loaded with osteoinductive growth factors, cells and drugs
Some effective FATs are already in clinical use

The potential of FATs still needs to be fully exploited

Further significant improvement of the clinical outcomes would be obtained

Tool the surgeon should not disregard when treating osteoporotic fractures
OSTEOPOROSIS: FROM EVIDENCE TO ACTION
December 4-5, 2009
Novotel Monte Carlo
Monte Carlo Monaco

CALL FOR ABSTRACTS

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AUGUST 15, 2009

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