Challenges of Fragility Fracture Treatment

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Optimal care of fragility fracture patient: Goals, challenges and solutions

- Keep the patient alive
- Fix the fracture
- Keep patient mobile
- Keep patient from returning to your fracture unit
- Acute medical management
- Surgical challenges
- Multidisciplinary rehab
- Osteoporosis management and secondary prevention

Quality control of process
Optimal care of fragility fracture patient: Goals, challenges and solutions

Keep the patient alive → Acute medical management
Complexity of elderly patients

- Mean age hip fracture = 80 yrs
- Comorbidities (median ASA 3)
  - Murmurs
  - Renal - Dialysis
  - COPD - home O2
  - Diabetes
  - Delirium / dementia
  - Pseudo-obstruction
  - Alcohol abuse
- Impaired metabolic response to injury
  - Hyponatraemia
- Management problems
  - Consent
  - Theatre scheduling
  - Discharge planning
- Polypharmacy
  - Warfarin
  - Plavix
  - Neurotropics
Acute medical management

- Slow but steady rise in age of patients presenting with fragility fractures. Many have multiple co-morbidities
- Difficult judgement – balance between medical optimisation and prompt surgery
- Inexperienced surgical trainees not the best people to look after such people and prepare them for surgery
- Ideal solution is close supervision by senior physicians having expertise with elderly patients
  - pre- and peri-operatively, not just for rehabilitation
Senior medical backup desired

• Can come from different specialists, depending on health care system
  – Anaesthesia
  – Cardiology
  – Internal medicine
  – Geriatrics
  – Respiratory medicine

• Orthogeriatrics may play larger role in future
The pay-off from orthogeriatric care in the acute phase

- Superior medical care
- Optimal scheduling of fracture surgery
- Better communication with patients and relatives
- A leader for the multidisciplinary team

Quality service is cheaper in the end
Alternative models for orthogeriatric care

- Orthopaedic doctors and nurses supported by visiting medical specialist
- Nurse specialists on fracture wards, supervised by geriatricians
- Geriatricians employed on fracture wards
- Elderly fracture patients admitted to geriatric wards
Optimal care of fragility fracture patient: Goals, challenges and solutions

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- Surgical challenges
Main surgical challenges

- Impaired ability of osteoporotic bone to hold screws
- Crushing of cancellous bone with creation of voids after fracture reduction

Altogether, these factors lead to a higher risk of failure at the implant-bone interface before healing achieved
Some surgical solutions

• Avoid the problem with arthroplasty
  – Allow early mobilisation

• Improve implants for osteoporotic bone
  – Fixed angle locking plates
  – Hydroxyapatite coating of screws

• Use IM nail instead of onlay devices for diaphyseal fractures

• Fill voids with cement
Proven arthroplasties relevant to challenging osteoporotic fractures

Images courtesy of John Keating
Arthroplasty as an alternative to fixation: Hip

- Hemiarthroplasty established and widely preferred to ORIF in displaced subcapital fractures
  - But still controversial
- Total arthroplasty increasing
Arthroplasty as an alternative to fixation: Knee

- Technically demanding
- Revision components often needed
- Complications common
Arthroplasty as an alternative to fixation: Shoulder

- Useful particularly for 3-part and 4-part fractures and fracture dislocations
- Early treatment best
- Good pain relief, but poor movement and function
- Soft tissues influence outcome
Arthroplasty as an alternative to fixation: Elbow

- C3 distal humerus, below condyles, radial head
- Good results in small, uncontrolled series
- Probably better than ORIF
- More studies needed
Locking plates

- Screw head threaded – engages with hole in plate
- Single mechanical unit – internal fixator
- No compressive force on periosteum
Fixed angle plate for shoulder

- Pullout from head less likely with diverging, fixed-angle screws
- Increases scope for ORIF as opposed to hemiarthroplasty
Fixation augmentation with hydroxyapatite-coated screws

- OsteoTite HA-coated external fixation pin
- HA-coated AO/ASIF lag screw
- HA-coated AO/ASIF cortical bone screw
- HA-coated AO/ASIF cancellous bone screw

Improved osseointegration with HA-coated screws

HA-coated dynamic hip screw

Study Aim:
To compare DHS fixed with standard vs HA-coated AO/ASIF screws in osteoporotic patients with trochanteric fractures

Standard  HA-coated
# Study population

<table>
<thead>
<tr>
<th></th>
<th>Standard Screws</th>
<th>HA-coated Screws</th>
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</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>81 ± 8</td>
<td>81 ± 6</td>
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<tr>
<td>BMD</td>
<td>538 ± 105</td>
<td>568 ± 111</td>
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<tr>
<td>AO A1</td>
<td>42%</td>
<td>48%</td>
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<tr>
<td>AO A2</td>
<td>58%</td>
<td>52%</td>
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Standard vs HA-coated screws: Femoral neck-shaft angle

- Standard Screws
- HA-Coated Screws

Angle (degrees)

POST-OP vs 6 MONTHS

p=0.008

Standard vs HA-coated screws

Harris Hip Score

Lag Screw Cut-out

Standard Screw: Complications

F 83yrs

POST-OP

2 MONTHS

6 MONTHS
Possible solution: HA-coated screw

Note bone growth around the tip of the screws beyond the exit cortex

F 82 yrs
HA-coated screws: Wrist external fixator

Caveat: HA-Coated Pins can be difficult to remove from cortical bone
Void filling with bone substitutes

- Deformation and loss of support by crushing of cancellous bone. Relevant in metaphyseal long-bone fractures and spine.
- Inert materials, such as PMMA cement, vs. potentially integrating scaffold, i.e. graft.
- Matrix (scaffold) plus or minus inductive molecules or cells.
Void filling with bone substitutes
Calcium phosphate cement augmentation
Void Filling / Support of trabecular bone in metaphyseal fractures

Maintains radial length, avoids re-operation and increases grip strength.

Constantz et al. Science 1995; 267:1796-99
Vertebral fragility fracture impairs quality of life more than we think

- Predicted prevalence of vertebral fractures in the E.U.
  - 2000: 23.7 million
  - 2050: 37.3 million
Vertebroplasty and kyphoplasty

- Filling void in crushed vertebral body with PMMA
- Patient prone – transpedicular injection of cement
- Vertebroplasty – high pressure injection – good pain relief
- Kyphoplasty – pre-insertion of balloon to create a void for low pressure injection – aiming for height restoration
Balloon kyphoplasty: Can you uncrush a bone?
Kyphoplasty
Efficacy of vertebroplasty and kyphoplasty

• Similar efficacy in pain relief, better than conservative treatment
• Kyphoplasty fewer adverse events (leakage, VTE)
  – Stronger evidence for functional and QOL Improvement
• Most experience to date with late, failed conservative cases
  – Sagittal correction with kyphoplasty may be better if performed earlier

Taylor et al. Spine. 2006; 31:2747-2755
Osteoporosis therapy and fracture healing

Theoretical concern:

Reduction of bone turnover by anti-resorptive drugs may inhibit fracture healing
Anti-resorptive drugs and fracture healing

- Large clinical trials of anti-resorptive agents
  - 2000 - 7000 patients over 3 years
  - no adverse events related to fracture healing

- Animal studies of fracture healing
  - delay in remodelling of callus
  - no positive effect on restoration of mechanical strength

- Bisphosphonate may delay loosening of implants

- No clinical trials in humans directly testing effect of anti-resorptive therapy on fracture healing
Raloxifene, estrogen and alendronate affect the processes of fracture repair differently in ovariectomized rats

• OVX vs sham-op in 3-month-old rats
  – Closed, nailed femoral shaft fracture
  – OVX alone, or with E, raloxifene (RAL), or alendronate (ALN)

• X-ray, QCT, biomechanical testing, histology
  – At 6 and 16 weeks

### Fracture healing properties vs sham control

<table>
<thead>
<tr>
<th></th>
<th>6 weeks</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Callus size</td>
<td>Ultimate load</td>
<td>BMC</td>
<td>Callus size</td>
<td>Ultimate load</td>
<td>BMC</td>
<td>Lamellar /woven</td>
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<tr>
<td>Ovx alone</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ovx + E</td>
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<tr>
<td>Ovx + RAL</td>
<td>-</td>
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<tr>
<td>Ovx + ALN</td>
<td>+</td>
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<td>+</td>
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Alendronate delayed callus remodelling (lower ratio of lamellar to woven bone), but larger callus was stronger

Balance of risks

Definite increase in fracture incidence if secondary prevention not initiated

Theoretical worries about importance of remodelling in fracture repair

But caution before treating with rigid internal fixation, requiring osteoclast-led remodelling
Anabolic therapy would remove this worry - preclinical evidence with PTH


- Several groups show enhanced fracture healing in animal models

Systemic bisphosphonate therapy may enhance HA-coated screw fixation

- Prospective randomised study in externally-fixed intertrochanteric fractures
  - Women aged 65+ with low BMD and no prior BP therapy
  - Intertrochanteric fracture (AO/OTA type A1 or A2)
- HA-coated pins in both groups
  - Group A: oral dose of 70 mg of Alendronate per week
  - Group B: no alendronate
- Screw insertion/extraction torque measured at insertion/removal
All the devices used in this study are FDA approved
Slides provided by A. Moroni, Bologna, Italy
## Baseline characteristics

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<th>Alendronate (n=8)</th>
<th>Control (n=8)</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>82 ± 8</td>
<td>78 ± 6 yrs</td>
</tr>
<tr>
<td>BMD</td>
<td>543 ± 87</td>
<td>527 ± 23</td>
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<tr>
<td>Quality of reduction*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>4</td>
<td>5</td>
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<tr>
<td>Acceptable</td>
<td>3</td>
<td>2</td>
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<tr>
<td>Poor</td>
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Screw extraction torque higher for cancellous bone in ALN vs control at 3 months

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Quality control of process
Multidisciplinary rehabilitation

• Goals
  – Restore quality of life through mobility
  – Prevent future fractures by preventing falls

• Should be led by the appropriate rehabilitationists

• Discharge planning – integration of medical and social services – needs to start immediately

• Nutrition a vital element
  – High protein diet improves recovery *
  – Vit D insufficiency very common, readily treated

Secondary prevention

• One of the strongest predictors of fragility fracture is having had one already
  – Bone strength
  – Tendency to fall

• Our response to a fragility fracture must include a determined attempt to prevent another one

• Need not require orthopaedic surgeons to treat, or even remember to refer
  – Needs a system that achieves this automatically
Systems for secondary prevention

• Most reliable when based on nurse specialists, e.g.
  – Fracture liaison nurses in fracture clinic
  – Fragility fracture nurse coordinators for inpatients

• Many different models possible
  – Key is that responsibility is clear

• Needs local agreement on referral mechanisms between fracture service, osteoporosis service and falls service

• Vital to involve GPs because prevention has to be life-long

• Essential to empower the patient by thorough education
Hip Fracture Audit

- Experience (e.g. in Scotland) has shown that ongoing, real-time audit, in conjunction with evidence-based guidelines, can change practice in a non-threatening way.
- Preferably national or regional, so that performance can be fed back in context of peers.
- Records process and outcome to one year.
- Owned and controlled by the professions.
- Raises the profile of osteoporosis and fragility fracture work with the managers and commissioners.
Summary

- Fragility fractures present a serious challenge to fracture services, both because of the high volume and because of their medical, surgical and logistic complexity.
- Multidisciplinary working is the key to success and alliance between orthopaedics and geriatrics is particularly valuable.
- Surgical technique must be adapted to take account of complications of fracture repair and healing in the elderly.
- It is absolutely necessary to deliver secondary prevention reliably to every patient.