Metastatic Bone Disease and Multiple Myeloma
Southwest Spine Institute

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Metastases to Bone

Metastatic bone carcinoma

- Originates from other cancers, such as breast, prostate, lung, renal cell, etc. and spreads to bone

- Metastatic cancer causes skeletal complications every 3-4 months\(^1\)

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Metastasis

• Cancer typically spreads to\(^1\):
  – Lymphatic system
  – Lungs
  – Liver
  – **Skeleton\(^2\)**
    – Vertebrae 75%
    – Pelvis 40%
    – Femur 25%

Classifications

• **Osteoblastic lesions**
  - Increase bone density
  - Do not change bone strength
  - Decrease bone stiffness
  - Characterized by increased bone formation

• Example:
  - Metastatic osteoblastic carcinoma
Metastatic Osteoblastic Carcinoma
Classifications

- **Osteolytic lesions**
  - Decrease both bone strength and stiffness
  - Characterized by increased bone resorption, causing swiss cheese type lesions on bone

- **Examples:**
  - Multiple Myeloma
  - Metastatic osteolytic carcinoma
Metastatic Osteolytic Carcinoma
Metastases to Bone

• Cancers that frequently metastasize to the skeleton include¹:
  • Breast cancer
    – 75% of cases
      » 65% of the lesions are lytic²
  • Lung cancer
    – 35% of cases
      » 80% of the lesions are lytic²
  • Kidney cancer
    – 25% of cases

Metastases to the Vertebrae

• > 70% of patients who die from cancer have vertebral metastases\(^1\)
• Lytic destruction of the anterior portion of the vertebral body\(^1\)
• Lytic lesions are associated with higher fracture risk
• Metastatic bone disease is painful\(^2\)
  – Up to 2/3 of patients experience severe pain and disability

Fracture Risk

- Osteolytic lesions = higher fracture rate
- Fracture probability increases with the duration of metastatic involvement\(^1\)
- Certain cancers almost always metastasize with osteolytic lesions\(^2\)

Biomechanics of Pathologic Spine Fractures

• Center of gravity (CG) moves forward
• Large bending moment created
• Posterior muscles and ligaments must counterbalance increased bending
• Anterior spine must resist larger compressive stresses

White III and Panjabi 1990
Radiation Therapy

• May leave bone unstable
• Radiation may increase risk of fracture\(^1\)
  – Up to 41% of patients who undergo radiation experience bone fractures
• Cannot correct an anatomic abnormality such as a fracture\(^2\)

Fracture Treatment

• Pain is due to spinal instability
  – radiotherapy or systemic treatment will not relieve the pain\(^1\)

• Stabilization is required for pain relief\(^1\)

• Spinal cord involvement and neurologic deficit possible if not stabilized\(^2\)

Multiple Myeloma

Picture courtesy of the International Myeloma Foundation
Multiple Myeloma

• Cancer of the bone marrow
• 75,000 – 100,000 patients in the US at any one time
• Over 13,500 new cases diagnosed each year in the US
• Male to female ratio is 3:2
• Trend towards patients under the age of 55

From “Multiple Myeloma: Cancer of the Bone Marrow.” International Myeloma Foundation, 2001 edition.
Multiple Myeloma

- Disruption of bone marrow function
- Suppression of immune function
- Osteoclasts activated
- Osteoblasts inhibited
- Hallmark is osteolytic lesions

Picture courtesy of the International Myeloma Foundation
Common Sites for Bone Involvement

- Skull
- Spine
- Pelvis
- Long bones

Picture courtesy of the International Myeloma Foundation
T-10 fracture due to multiple myeloma

Photo courtesy of Steve James, M.D.
T2 weighted MRI showing myeloma related fracture at L3 and L4
Vertebral Body Compression Fracture Treatment Options
Why have we been content to leave the spine in a physiologically and biomechanically compromised condition?
Fracture Treatment Objectives

Four AO principles¹

- **Fracture reduction** and fixation to restore anatomical relationships
- **Stability** by fixation or splintage, as the nature of the fracture and the injury requires
- **Preservation of blood supply** to soft tissues and bone by careful handling and **gentle reduction techniques**
- **Early and safe mobilization** of the part and the patient

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*Arbeitsgemeinschaft Osteosynthesefragen*  
(English translation: Association for the Study of Internal Fixation - ASIF)  
¹ Ruedi & Murphy, AO Principles of Fracture Management,  
Thieme, Stuttgart, New York, 2000
Vertebral Body Compression Fracture (VCF)

- Normal: Wedge-shaped
- Fractured: Depressed endplate(s), Spine shorter, tilted forward
Deformity Progression

Lieberman et al., Spine 2001
VCF Treatment Options

Medical Management

- Treatment Protocol
  - Bed rest
  - Narcotic analgesics
  - Braces

- Shortcomings
  - May fail to relieve pain
  - Does not provide long-term functional improvement
  - May exacerbate bone loss
  - Does not attempt to restore the anatomy
VCF Treatment Options

Open Surgical Treatment

- **Indication**
  - Only if neurologic deficit (very rare, only 0.05%)
  - Instrumented fusion, anterior or posterior

- **Shortcomings**
  - Invasive
  - Poor outcomes in osteopenic bone
Vertebroplasty

- Designed to stabilize painful VCFs
- Shortcomings
  - Risk of filler leaks (27-74% reported\(^1,2,4,5,6,7,8,9,10\))
    - High pressure injection
    - Uncontrolled fill
    - High complication rate (1-20% reported\(^3,4,5\))
  - Freezes spinal deformity
    - Does not reduce fracture or restore anatomy
    - Not designed to reposition bone

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1 Cortet et al., J Rheum 1999
2 Alvarez et al., Eurospine 2001
3 Padovani et al., AJNR 1997
4 Weill et al., Radiology 1996
5 Jensen et al., AJNR 1997
6 Cotten et al., Radiology 1996
7 Gaughen et al., AJNR 2002
8 Grados et al., Rheumatology 2000
9 Peh et al., Radiology 2002
10 Ryu et al., J Neurosurgery 2002
Why Fracture Reduction?

- What is orthopedic reduction?
  - The restoration, by surgical or manipulative procedures, of a part to its normal anatomical relation
- What is the goal?
  - To produce optimal outcomes with early diagnosis and treatment
  - To accommodate the frail physical status and co-morbidities of geriatric patients

2 Brakoniecki, Anesthetic Management of the Trauma Patient with Skeletal Injuries, Skeletal Trauma, W.B. Saunders Company, 1998, 1:7:171-172
New VCF Treatment Option

Minimally Invasive Fracture Reduction
Minimally Invasive Fracture Reduction

KyphX® Inflatable Bone Tamp (IBT)
For use as a conventional bone tamp for the reduction of fractures and/or creation of a void in cancellous bone in the spine, hand, tibia, radius and calcaneus.
KyphX® Introducer Tool Kit

Allows precise, minimally invasive access to the vertebral body and provides a working channel.
KyphX® IBT Inflation

Reduces the fracture, compacts the bone, and may elevate the endplates.
Leaves a defined cavity within the vertebral body
Minimally Invasive Fracture Reduction

Clinical Experience

- Over 3 years of orthopedic fracture reduction
- As of June 30, 2002
  - Fractures reduced > 22,000
  - Patients > 17,000
Minimally Invasive Fracture Reduction

KyphX® Inflatable Bone Tamp has been developed for patients with symptomatic VCFs
Possible causes of VCFs

- Primary osteoporosis
- Secondary osteoporosis
  - Drug-induced (corticosteroids, tobacco, barbituates, heparin)
  - Endocrine (hyperparathyroidism, diabetes)
  - Miscellaneous (renal failure, COPD, rheumatoid arthritits, hepatic disease or transplant)

Possible causes of VCFs

- Osteolytic lesions
  - Multiple Myeloma
  - Bone metastases
  - Paget’s disease
- Trauma
  - ½ of all trauma cases are misclassified
The general goal for fracture treatment is restoration of anatomy and early return to function.

Conventional therapy not always effective.

KyphX® IBT is a new option for VCFs designed to:
- reduce the fracture
- move cancellous bone (elevate endplates)
- create void inside vertebral body

As with hip fracture surgery, early diagnosis and intervention are important for fracture reduction.
Case Study

Patient: 55 YO Male
Diagnosis: Multiple Myeloma
Fracture Reduced: L-1, 3 day old
Case Study

Patient: 61 YO Female
Diagnosis: Multiple Myeloma
Fracture Reduced: T11-L2, 1 ½ yrs old
Case Study

Patient: 61 YO Male
Diagnosis: Multiple Myeloma
Fracture Reduced: T-11, 5 weeks o
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Thank you!