Vertebroplasty for Osteoporotic Vertebral Compression Fractures

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Agenda

- Patient Presentation
- Vertebral Compression Fractures
- Vertebroplasty
- Alternate Treatment Options
- Summary
Patient Presentation

- Ms. BL is a 84 y.o. woman with hx of osteoporosis & multiple vertebral compression fractures
- HPI
  - Several weeks severe back pain
  - No inciting event
  - Worse when standing
- PE
  - Kyphosis
  - Deep pressure over T8 – T9 spinous processes reproduces pain

Neurologist suspected a new VCF and ordered a plain film of the thoracic spine
Ms. BL: Wedge-shaped Deformities of Vertebral Bodies on Plain Film

- Loss of height of T8 and T9 bodies with wedge-shaped deformity
- Focal kyphosis at T8/T9
- Generalized demineralization characteristic of osteoporosis
# Differential Diagnosis for Wedge-shaped Deformities of Vertebral Bodies

**Wedge VCF**
2/2 various causes  
+ Minor Trauma

- Osteoporosis (common)
  - Post-menopausal
  - Steroid-induced
- Metastases (common)
- Hemangioma
- Multiple myeloma
- Infection/osteomyelitis
- Paget’s disease
- Langerhan’s cell histiocytosis

**Congenital**

- Normal variant
- Congenital syndromes with thoracolumbar wedging
  - Achondroplasia
  - Hypothyroidism
  - Mucopolysaccharidoses
- Scheuermann’s disease
Based on identifiers (age/gender), HPI, and PMH, our patient likely has a wedge VCF 2/2 to osteoporosis ± minor trauma.
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Overview of VCFs and Osteoporosis

- **Vertebral compression fractures**
  - 700,000+ per year in U.S., most often 2/2 to osteoporosis
  - Pain is main complaint (although many if not most are asymptomatic), and history of minor trauma may or may not be noted
  - Increased risk of hospitalization and mortality, particularly secondary to pulmonary causes

- **Osteoporosis**
  - Over 10 million individuals in U.S.
  - Fractures common (25-50% of 50+ y.o. will fracture)
  - Most common cause of VCFs
Let’s review some relevant anatomy for VCFs
- VCF occurs in the vertebral body
- Vertebroplasty most often employs a transpedicular approach. A needle is placed through one or both of the pedicles, avoiding vital surrounding structures.
Spinal nerves exit intervertebral foramina. In vertebroplasty, cement extravasation in this area can lead to adverse events.
Anatomy: Veins of Vertebral Column

- **Posterior Internal Venous Plexus**
- **Anterior Internal Venous Plexus**
- **Basivertebral Vein**

- Proximity of venous plexus to intervention can lead to cement emboli in the venous circulation

Anatomy: Surrounding Soft Tissues

- **Trajectory of Intervention**
  - Soft tissues traversed include SC fat, fascia, and erector spinae musculature

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Vertebroplasty Diagram

- Percutaneous, imaging-guided procedure where radio-opaque cement is injected into compressed vertebra
  - Needle(s) are strategically placed, providing for a conduit from the outside world to the interior of the vertebral body
  - Cement is injected through the hollow needle

- Aim of procedure is to achieve pain control and to strengthen bone
  - Note that the procedure does not restore height to the vertebral body, unlike some newer techniques such as kyphoplasty

- Performed by interventional radiologists (70%) as well as orthopedic surgeons, neurosurgeons, and anesthesiologists

Vertebroplasty was first performed in 1984 by radiologists in France

- Procedure was performed in a middle-aged female patient with a painful hemangioma in her cervical vertebra
- Pain relief was immediate

Vertebroplasty was introduced to U.S. in 1994. Today it used most commonly for osteoporotic VCFs

- Tremendous growth in popularity
  - Pain relief often immediate and dramatic, such that some patients call it “miraculous”
  - Outpatient procedure with overnight admission at most

### Patient Selection

#### Common Indications
- Acute or healing VCF 2/2 osteoporosis, multiple myeloma, metastatic lesions
- Severe focal midline pain at fracture level
- No radicular signs/sx
- Attempted conservative management for 6-12 wks

#### Contraindications
- Unstable fracture (posterior element involvement)
- Uncontrollable bleeding
- Infection
- No complaint of pain
Let’s follow Ms. BL’s vertebroplasty experience
Initial imaging study
Identify structural alteration of vertebral body

Typically the second imaging study
Fluid-sensitive sequences (T2-weighted with fat suppression or short tau inversion recovery (STIR)) identifies bone marrow edema indicative of acute or healing fracture

Bone scintigraphy used when MRI contraindicated
Increased uptake in acute or healing fracture

Can be used to explore bony structures in complicated fractures
Not regularly employed
Ms. BL: Wedge VCF on Plain Film

Radiologic Assessment → Patient Preparation → Needle Placement → Injection → Post-Op Care

XR

Wedge VCFs of T8 & T9

PACS, BIDMC
Lateral Thoracic Spine XR
Ms. BL: Acute Wedge VCF on MRI

Wedge VCFs in T8 and T9 with:
- Areas of low signal corresponding to fracture lines and trabecular impaction

Older VCFs in T4 and T12 with no abnormalities signal relative to surrounding vertebrae

T2-Weighted Sagittal MRI of Thoracic Spine
Ms. BL: Acute Wedge VCF on MRI with Fluid Sensitive Sequence

Wedge VCFs in T8 and T9 with:
- Focal areas of increased signal suggesting bone marrow edema
- Reflective of acuity
- T9 > T8

T2-Weighted STIR-Sequence Sagittal MRI of Thoracic Spine
Setting up

- NPO after midnight
- Moderate sedation (e.g., propofol titrated to need)
  - Severe pain may require general anesthesia
- Prophylactic broad spectrum antibiotic administered
- Patient lies prone on table
- Aseptic protocol

Vertebroplasty Suite

http://www.radiologyinfo.ca/default.aspx?page=87
- Fluoroscopic guidance employed throughout
- Thin gauge spinal needles placed for visual guidance along lateral-to-medial trajectory
- Small skin incision is made using a scalpel
- Stylet accompanied by large bore needle (11 or 13-gauge) is used to enter soft tissues along the same trajectory as the spinal needles, and then penetrate the pedicles
- Advance tip into the anterior 1/3 of vertebral body
Needle tip advanced to anterior 1/3 of vertebral body

Needle enters and traverses pedicle

Needle trajectory in a lateral-to-medial fashion
Ms. BL: Spinal Needle Placement on AP Fluoroscopy

Pedicles

Spinal needles

Sternotomy wires from prior procedure
Ms. BL: Spinal Needle Placement on Lateral Fluoroscopy

- Vertebral Body
- Transverse Process
- Spinous Process
- Pedicle

Spinal needles

Lateral Fluoroscopy Image
Ms. BL: Stylet Placement on Fluoroscopy

Stylet & Needle

- Screw in with clockwise motion
- Hammer

Spinal needle


AP Fluoroscopy Image
Ms. BL: Large-bore Needle Placement on Fluoroscopy

Large-bore needles within vertebral bodies bilaterally

Spinal needles no longer present
Cement Injection

- Polymethyl methacrylate (PMMA) cement mixed with sterile barium or tungsten powder (opacifier)

- Typically 4-12 cc of cement injected

- Why does it work?
  - Mechanical support/stability
  - ? Tumoricidal effect
  - ? Chemical/heat ablation of pain fibers
Ms. BL: Cement Injection on Fluoroscopy

Lateral Fluoroscopy Image

Large-bore needles within vertebral body bilaterally

Injection of cement into vertebral body

PACS, BIDMC
Does anything strike you as abnormal?
Let’s look at the image again
Although cement is being injected into the T8 vertebral body, we see cement in the T9 vertebral body as well.
Ms. BL: Extravasation of Cement and Communication of T8 & T9 on Fluoroscopy

In this patient, cement extravasated from the vertebral body of T8 and entered the vertebral body of T9 via an anterior communication.

This is a rather unusual finding.
Ms. BL: T8 to T9 Communication Confirmed on Fluoroscopy

Large-bore needles within T8 vertebral body

Cement within T9 vertebral body

In conjunction with the lateral view, we can prove that the cement is within (not outside) the vertebral body

This confirms the anterior communication between T8 and T9
Where should the cement be?
Let’s look at another patient.
Large-bore needles within T10 vertebral body

Cement should stay within the vertebral body, as in this companion patient

Image courtesy of Erica Gupta, MD
Companion Patient: Cement Injection on AP Fluoroscopy

Large-bore needles within T10 vertebral body

Cement confirmed to be within vertebral body on AP view

This is where the cement should be

Image courtesy of Erica Gupta, MD
Back to our patient Ms. BL
Ms. BL: Needle Removal s/p Cement Injection on Fluoroscopy

Large bore needle being extracted from vertebral body

Cement within vertebral bodies of T8 and T9
Recovery and Discharge

- Lie supine for 2 hr for cement hardening
- Observe initial ambulation
- If new pain, CT scan to evaluate distribution of cement
- Discharge with pain management plan
Ms. BL had no complications and experienced almost immediate pain relief. She was discharged home after the observation period.
## Complications of Vertebroplasty

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<th>Acute</th>
<th>Chronic</th>
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<td>- Cement extravasation posteriorly into spinal canal, neuroforamen, or other surrounding tissues</td>
<td>- Possible increased risk of new VCFs s/p vertebroplasty</td>
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<td>- 30-93% of cases</td>
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<td>- Usually clinically insignificant</td>
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<td>- Cement emboli via venous plexus</td>
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<td>- Allergic reaction to cement</td>
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Medical Management for VCFs

- Activity modification
- External back-bracing
- Assistive devices
- Narcotic analgesics
- Physical therapy
- Therapy targeted at underlying pathology (e.g., osteoporosis medication)
Despite being used for 10+ years, there is a dearth of reliable efficacy data vs. medical management

- Only 1 RCT
  - Showed short-term superiority of vertebroplasty to medical management
  - Trial only examined out to 2 weeks
- Long-term studies show no difference in pain/mobility at 1 or 2 yrs
- Difficult to assess true efficacy of vertebroplasty due to lack of rigorous studies

Based on limited data, vertebroplasty likely creates most value because of early improvement

- Fast pain relief
- Short time to functional recovery
- Little analgesic medication
- Minimal to no hospital stay
New Interventions for VCFs

- **Kyphoplasty**
  - Angioplasty-like balloon inflated in vertebral body before cement injection
  - Restores vertebral height in addition to pain relief

- **SKyphoplasty™**
  - Coiled plastic tube opens up like popcorn to create cavity before cement injection
  - New technique and device (SKy Bone Expander™ from Kyphon)

Role of each of these will be determined going forward…

http://www.neurosurgery.pitt.edu/spine/conditions/vertebral_fractures.html

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Osteoporotic vertebral compression fractures are common and are accompanied by morbidity/mortality.

Imaging begins with plain film, but MRI is employed to identify target vertebra(e) for intervention.

In vertebroplasty, injected cement stabilizes the fracture, thus relieving pain.

Vertebroplasty is effective in the right patient population, but further trials are needed.
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References

2. Felson’s Gamuts in Radiology.