Lesson S04: PreAnesthetic Assessment of the Patient for Vertebroplasty

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Needs assessment

There is an ever-increasing need for the expertise of anesthesiologists outside of the operating room in both ambulatory surgery and interventional radiology settings. Practicing in such environments presents new challenges. Clinical anesthesiologists must possess an understanding of the requirements specific to providing care to patients undergoing procedures, such as vertebroplasty, in these settings.

Objectives

At the end of the lesson, the participant will be able to:

1. Cite the incidence of osteoporosis.
2. Identify causes and consequences of vertebral collapse.
3. Understand the differences between vertebroplasty and kyphoplasty.
4. Describe the principles behind vertebroplasty and cite its indications.
5. Understand the special needs of providing anesthesia in the radiology suite.
6. Anticipate problems and complications of the procedure.
7. Outline appropriate preanesthetic requirements.
8. Present an anesthetic and analgesic plan.
9. Identify changes in lung dynamics caused by vertebral fractures and position changes.
10. Prepare a plan for postanesthetic care.
Case Presentation

An 84 year old Chinese woman with marked osteoporosis and several lumbar and thoracic vertebral fractures presented to the hospital with severe pain. She had been followed in the pain clinic for several years and received epidural steroid injections and several courses of opioid patches without improvement. She was bed-ridden with a history of multiple bouts of aspiration pneumonia and urinary tract infections. Her Hb level was 9.9 gm. She could not lie flat because of pain. She had a past history of hypertension and was treated with hydrochlorothiazide and metoprolol. Other medications included oxycodone, acetaminophen, omeprazole, albuterol inhaler, and sertraline. Cardiac function was reported to be normal by echocardiography. Multilevel vertebroplasty and kyphoplasty were planned in the neuroradiology suite. The patient had hemangiomas at several levels which the interventionalist planned to image and treat at a later time when the patient would have less pain. The neuroradiologist requested moderate sedation administered by an anesthesiologist.

Osteoporosis

Osteoporosis, or porous bone, is a disease characterized by low bone mass and structural deterioration of bone tissue. The resulting bone fragility leads to increased risk of fracture for all bones with a propensity for fractures of the hip, spine and wrist. These “fragility fractures” cause both acute and chronic pain and are a major source of morbidity and mortality in the United States. According to the National Institutes of Health on Osteoporosis, 10 million Americans suffer from osteoporosis and an additional 34 million are classified as having low bone mass. Over the age of 50, one in every two women and one in every four men will sustain an osteoporosis related fracture. Osteoporosis is responsible for an estimated 1.5 million fractures annually, including >700,000 vertebral compression fractures, costing approximately 17 billion dollars in direct national expenditure. As longevity increases for a larger segment of the population, costs are estimated to rise to 60 billion dollars per year by 2030 – an expenditure of 164 million dollars each day. The population at risk includes geriatric Caucasian and Asian women. Other risk factors include poor nutritional status, a history of a primary relative with bone fragility, inactive lifestyle, early menopause, smoking, steroid use and alcohol use. Diagnosis is made utilizing a bone mineral density test and a dual-energy x-ray absorptiometry (DEXA) test.

Treatment of Osteoporosis

Osteoporosis is a progressive disease. The primary focus of treatment is pain management with strategies such as facet blocks, radiofrequency stimulation, epidural steroid injections and application of slow releasing opioid patches. Patients frequently self-medicate with non steroidal anti-inflammatory medications and herbal or natural substances. There have recently been orthopedic techniques described which attempt to stabilize a collapsed or deteriorated bone.

Vertebroplasty

Percutaneous vertebroplasty (PV) is a minimally invasive therapy that involves the injection of polymethylmethacrylate (PMMA, liquid or powder) into a collapsed vertebral body for the purpose of stabilizing it. Kyphoplasty is a similar technique that requires the insertion of a balloon under fluoroscopic visualization to create an intervertebral stabilizing pocket which is then filled with a synthetic bone substitute such as resin material, calcium phosphate or sulfate cement or a
formulations of PMMA. These filling materials have good biocompatibility, good biomechanical strength and stiffness and sufficient radio opacity for the fluoroscopy guided procedure.\textsuperscript{4,5}

As the efficiency of vertebroplasty to dramatically decrease pain was repeatedly demonstrated, the procedure was increasingly applied to relieve the pain of sicker patients.\textsuperscript{6,7} The anesthesiologist is challenged to create an analgesic plan that considers the unique circumstances of the patient in a distant surgical location.

Percutaneous vertebroplasty was first described by Herve Deramond in 1984 for the treatment of painful vertebral angiomas. It is a minimally invasive procedure that is presently used as a palliative treatment for osteoporotic and malignant vertebral lesions which weaken vertebrae and cause chronic pain.\textsuperscript{6} Over 70 studies involving more than 4000 patients have now been published. The technique has been shown to have a low rate of complications and provide both immediate pain relief and improvement in mobility.

Improvement in pain scores is dramatic. One study of 222 patients undergoing 360 procedures reported an immediate reduction in pain score from 8 at baseline to 1 at the end point (89%) (p = 0.0001).\textsuperscript{8} In another study of 204 patients, 61% were able to give up brace support, and 62% no longer required any drug therapy following the procedure.\textsuperscript{7} Beneficial results appear to be long standing, although some have argued that pain relief may be due to the direct injection of local anesthetics. To further evaluate this phenomenon, an investigational trial (INVEST) was launched in December 2007 which recruited 166 patients to be studied over a 5 year period.\textsuperscript{9} Patients were randomized into groups to receive cement implantation or local anesthesia alone. (Trial registration: Current Controlled Trials ISRCTN81871888)

Patient selection criteria for vertebroplasty include:

1. New fracture (1-7 months).
2. Pain refractory to medical management (bed rest, analgesics, calcitonin, or external bracing).
3. Respiratory compromise.
4. Potential for worsening of disease.

Patient exclusion criteria include:

1. Vertebral body height loss of 100%.
2. Posterior wall involvement.
3. Involvement of the spinal cord.
4. Osteolytic metastatic lesions.
5. Bleeding diathesis.
6. Inability to undergo emergency decompressive surgery.

Most of the exclusion criteria relate to the potential for complications.
Percutaneous vertebroplasty (PV) is a fluoroscopic guided injection of bone cement into a compressed vertebral body. Four steps are involved:

1. Vertebral puncture to access the surgical site.
2. Spinal biopsy to rule out metastasis and, in some cases, to aid in diagnosis. This is not performed if angioma is suspected.
3. Vertebral venography to identify perivertebral drainage and extravasation of cement.
4. Injection of PMMA.

There are complications associated with each step of the procedure. A vertebral puncture can enter surrounding structures such as veins, arteries, and the pleura. The needle can also disrupt the internal cortex of the pedicle, increasing the risk of PMMA leakage. Risk of extravasation is increased by the presence of osteoporotic and osteolytic lesions. Leakage of PMMA into perivertebral veins occurs in 30-67% of cases and can cause radiculopathy or embolization. Rarely there may be interference with pulse oximetry readings. Radicular pain has occurred with PMMA leakage into the neural foramina via cortical fractures, micro fractures, or destruction of venous channels. Pain has also occurred without an identifiable leak. Treatment with non steroidal anti-inflammatory agents is generally successful, suggesting an inflammatory reaction to the cement. The most severe complication of PMMA leakage is spinal cord compression and requires immediate surgical decompression. Other complications particular to PMMA are hypotension, hypoxemia, and cardiac arrhythmias. A case of cardiac perforation and tricuspid regurgitation has been reported. Only transient hypotension has been noted with PV, due to the minimal amount of PMMA injected. A review of 117 patients who underwent PV identified 8 cases with complications. Six were local problems (puncture site hematoma, radiculopathy), and 2 had pulmonary embolisms from cement migration. The risk of cement leakage is greater with vertebroplasty than kyphoplasty - 41% versus 4%. Thus complications are more common with vertebroplasty.

**Kyphoplasty**

Kyphoplasty (Kyphon Corporation®, Santa Clara, CA) is a procedure that both stops further compression and fixes the spinal deformity. PV only prevents further vertebral destruction. Kyphoplasty is more suitable for patients with metastatic lesions as a better supporting structure is created. The steps in the procedure are substantially similar to vertebroplasty except tamponading balloons are inserted into both sides of the body of the fractured vertebrae. The balloons are inflated under direct visualization to compact the cancellous bone and reexpand the vertebral body. PMMA is then inserted into the cavity. If done within three months of the onset of pain, kyphosis can be decreased by 50%. Complications have included epidural hematoma associated with postoperative heparin administration, lower extremity motor loss from cement extravasation into the spinal column, and anterior cord syndrome. In general, complications are lesser than those associated with PV because of greater containment of cement.
**Hemangiomas**

For patients with hemangiomas, arteriovenous malformations or tumors of the spine, embolization is effective in decreasing blood supply to the lesion. This may be performed as definitive therapy or to render the lesion more amenable to surgery at a later date.\(^\text{14}\) The technique involves the cannulation of a femoral vessel with the patient in a supine position. The catheter is carefully manipulated into the affected area. Particles of polyvinyl alcohol, Gel foam®, bone cement or a cyanoacrylate based synthetic glue are injected into the vessel to be occluded. To minimize complications, the patient must stay absolutely still and therefore general anesthesia is preferable. The duration of the procedure is variable and difficult to predict. The procedure table is frequently moved to allow the interventionalist an optimum view of several monitors. These monitors may be placed between the anesthesiologist and the patient. Simple placement of a supraglottic airway may make it difficult to manage respiration. During this procedure, ventilation must be controlled as it is frequently suspended for a few seconds to obtain accurate images.

Hemangiomas are often multiple, occurring throughout the spine. Thus, communication with the radiologist is important to understand the extent of the lesions, especially if they have been identified in the cervical area. The need for hemodynamic stability is underscored. If the purpose of embolization is to decrease blood supply to a tumor, then the primary and/or other metastatic sites should be known, if possible.

**Preanesthetic Assessment**

Preanesthetic assessment is a critical step in preparing an anesthetic plan for patients undergoing these types of procedures. Patients with chronic back problems frequently have numerous comorbidities and are subsequently treated with many medications. A comprehensive preanesthetic review should include evaluation of the following:

1. Cardiac disease
2. Pulmonary compromise
3. Urinary tract infection
4. Multiple medications
5. Metastatic disease
6. Poor nutritional status
7. Narcotic dependency
8. Limited mobility

Cardiovascular and pulmonary comorbidities are more likely to be present with increasing age. Pulmonary function is known to be compromised in patients with osteoporotic vertebral fractures. This is particularly significant for patients with already reduced pulmonary and cardiovascular reserve.\(^\text{15}\) In performing calculations of pulmonary function, the patient’s height should be accurately measured. Height may decline with age and patients often quote their height from younger years. By adjusting for this change, a statistically significant decrease in vital capacity and FEV1, suggestive of a restrictive lung pattern, may be properly identified.
The mortality rate from pulmonary disease (other than lung cancer) is also increased with the presence of osteoporotic vertebral fractures. Vertebral fractures may be caused by metastatic lesions with a known or unknown primary source.

Vertebral fractures also affect the gastrointestinal system. Loss of vertebral height decreases abdominal space and compromises gastrointestinal function. Long term opioid use causes constipation and decreases nutrient absorption. Psychological well being is adversely affected by insomnia and depressive effects of chronic pain.

Apart from prescribed medications, patients often take herbal preparations, believing them to be natural and safe. A history of recent ingestion of ginseng, garlic, gingko and ginger should be especially sought as these compounds may increase the likelihood of bleeding. Depending on the circumstances and the needs of the patient and proceduralist, it may be prudent to delay procedures in patients receiving anticoagulant therapy. Although the risk of bleeding is small, it is not insignificant.

Prior to undergoing vertebroplasty or kyphoplasty, results of a full blood count, electrolyte estimations and a coagulation profile should be available. Although bleeding is very rare, type and screen should also be available because of proximity to large vessels. If possible, an assessment of cardiac status and the ability to lie flat for approximately 1 hour should be known.

Positioning the patient suffering from osteoporotic and/or vertebral fractures may cause excruciating pain. Anesthetic induction or administration of adequate analgesia prior to movement to or positioning on the operating table is often required. Also, such patients have limited range of motion and an increased risk of fracture. If possible, the range of motion should be assessed pre-operatively. Radiolucent bolsters and/or an air mattress should be considered for positioning. Positioning for these procedures also requires that the vertebrae well aligned with limitation of movement, avoiding stretch on the brachial plexus and limb girdle, and placing the hands and feet in anatomically neutral positions.

### The Interventional Radiology Suite

The logistics of the interventional radiology suite poses both physical and mental challenges for the anesthesiologist. There are typically 4 viewing screens for the radiologist placed between the anesthetic machine and the patient. The anesthesiologist must become acquainted with the physical arrangement and plan for sufficient lengths of tubing and wires for oxygen and monitoring equipment. The procedure table is flat, solid and not articulated, and it is moved frequently. In most surgical centers, the radiology suite is located at a considerable distance from the operating room. The anesthesiologist must ensure that all supplies and equipment are available and in good working order. Because of the radiation involved, appropriate protective covering is necessary. Mobile phones and beepers do not work if kept in a pocket under a lead apron. Access to a land telephone line is essential for emergencies.
Anesthetic Management

Although small doses of midazolam, fentanyl and occasional boluses of propofol often suffice, such a technique may not provide adequate pain control for the patient and create less than optimum conditions for the neuroradiologist. Supplemental low dose propofol, remifentanil infusion, or dexmedetomidine may be used. Supraglottic devices have been used successfully and should always be immediately available. Another technique involves fluoroscopically guided spinal needle insertion and small doses of spinal anesthesia under minimal sedation. Regional anesthesia has not gained popularity in this group of patients. The potential risk of apnea can be avoided by using no more than 1 ml of bupivacaine 0.5% with 25ug of fentanyl.

While the procedure may be done on an outpatient basis, patients are usually observed for 24 hours. Arrangements should be made to transfer the patient to a postanesthetic care unit for appropriate monitoring. While many interventional radiology suites have an area set aside for short term observation of patients who have undergone imaging studies, staffing often does not include personnel trained to promptly recognize neurological changes that require urgent attention.

Management of the Case

The patient was brought into the neuroradiology suite in a bed in a semi-sitting position, breathing oxygen at 2 liters/minute. Respiratory rate was 30 breaths/minute; blood pressure was 165/90; pulse rate was 64 beats/minute. She was very apprehensive, gripping the bed sheets. Her son was present and provided translation to the patient. Details of the procedure and the anesthetic involvement and expectation were explained. Midazolam 1mg was given intravenously while she was still in the supine position. The neuroradiologist requested that the patient be placed in the prone position for the vertebroplasties. He could not provide an estimate of the length of the procedures and was working with new equipment. He planned to insert balloons on both sides of the L1 vertebral body and to inject cement at two other thoracic levels.

While moving the patient to the imaging table and attempting to position her prone, the patient expressed that she was in severe pain. Standard ASA monitors were applied and she was medicated with an additional midazolam 0.5mg and fentanyl 25ug. SPO$_2$ was noted to be 96% on supplemental oxygen. She was turned to a semi prone position, was moaning and could not lie still. Pulse rate was 66 and SPO$_2$ was 95%. BP increased to 200/100 and labetalol 15mg in divided doses was added. After 5 minutes, an additional fentanyl 25ug was given. Ten minutes later she was noted to be comfortable and calm and was properly positioned to commence the procedure. Supplemental oxygen was given throughout. Prior to injection of cement, propofol 20mg was given and a propofol infusion at 30ug/kg/min started. An additional 2 doses of fentanyl, 25 ug were given. The procedure lasted 45 minutes. At the conclusion, the patient was awake and place in a postanesthetic recovery room. She was discharged the following day with considerable pain relief.
References


**Further Reading**


POST-TEST

1. **Vertebroplasty:**
   a. Involves the injection of polymethylmethacrylate
   b. Treats osteoporosis
   c. Is minimally invasive
   d. All of the above

2. **Criteria for vertebroplasty include:**
   a. Treatment of old fractures
   b. Pain refractory to medical management
   c. Stable condition
   d. Single level disease

3. **Osteoporosis:**
   a. Affects 50 million Americans today
   b. Is more common in women
   c. Causes areas of high bone mass with interspersed structural deterioration of bone mass
   d. Rarely results in fractures

4. **Risk factors for osteoporosis include:**
   a. Poor nutritional status
   b. Active life style
   c. Afro-American heritage
   d. Non smokers

5. **Exclusion criteria for vertebroplasty include:**
   a. Anterior wall involvement
   b. ASA classification of 4-5
   c. Disease limited only to the vertebral body
   d. Minimal vertebral body height loss
6. **Significant complications of vertebroplasty include:**
   a. Polymethylmethacrylate leakage in < 5% of cases
   b. Frequent interference with pulse oximetry
   c. Pain not relieved by non-steroidal analgesic agents
   d. Compression of the spinal cord

7. **Patients presenting for vertebroplasty:**
   a. Often have several co-morbidities
   b. May have several opioid patches on their bodies
   c. Are often elderly
   d. All of the above

8. **Advantages for the anesthesiologist who care for patients in the interventional radiology suite during vertebroplasty include:**
   a. No need for radiation protection
   b. Easy access to communication
   c. Ready availability of support personnel
   d. Prompt relief of pain for the patient

9. **Anesthesia for patients undergoing vertebroplasty is best managed by:**
   a. Small doses of midazolam, propofol and fentanyl
   b. General endotracheal anesthesia
   c. Spinal block
   d. No anesthesia is usually required, local blockade suffices

10. **Postanesthetic care:**
    a. Should be provided for about 24 hours in hospital
    b. Is rarely needed as the patient goes home within the hour
    c. Preferably should be in an ICU unit because of the high incidence of neurologic complications
    d. Depends on the patient’s preference