Vertebroplasty

By Ramsin Benyamin, MD

Osteoporosis has reached epidemic proportions and is a major public health threat for an estimated 44 million Americans.[1] According to the 2005 annual report of National Osteoporosis Foundation one in every two women and one in every four men aged 50 or older will suffer an osteoporosis-related fracture during their lives. Vertebral compression fractures (VCFs) constitute the most frequent complication of osteoporosis with almost half of all the 2 million bone fractures caused by osteoporosis.[2] The estimated medical cost of osteoporotic fractures in 2005 was 16.9 billion dollars. Prevalence of VCFs increases with age, reaching 40% in 80-year-old women.[3] Women with clinically diagnosed VCFs have a 15% higher mortality rate and are 2 to 3 times more likely to die of pulmonary causes.[4,5] Over 50% of those with 1 or 2 VCF require self-care assistance which is significantly higher compared to 8% of Osteoarthritis patients suffering from low back pain. Also, it is worth mentioning that each VCF increases the chance of another VCF to 19.2% within a year, and 2 VCFs increase it to 24%.

Osteoporotic VCFs are associated with significant morbidities and impaired quality of life the majority of which is caused by pain and immobility. The severe pain caused by VCF is typically exacerbated while weight-bearing and if not treated leads to chronic pain associated with depression and/or anxiety. Every VCF reduces the forced vital capacity by 9% leading to increased risk of developing atelectasis and pneumonia. Immobility can lead to worsening of osteoporosis, 1-3% muscle wasting per day, decubitus ulcers and risk of deep vein thrombosis and subsequent pulmonary embolism. Opioids prescribed for treatment of pain in addition to immobility may cause lack of appetite, nausea and constipation.

The morbidity and mortality associated with osteoporotic vertebral fractures demands the need for more aggressive treatment and therefore vertebral augmentation techniques like vertebroplasty have emerged as a viable treatment option resulting in rapid pain relief and improved mobility. Some have called percutaneous vertebroplasty a developing standard of care for VCF.[6] Evidence is promising and despite the fact that level one evidence is lacking (mostly due to difficulty in recruiting subjects to serve as controls), vertebroplasty is now considered a routine procedure.[7] The significant number of publications (in excess of 500) reflects the enthusiasm of medical community in pursue of solid evidence for this very gratifying procedure. Having a dedicated clinical practice to evaluate, treat and follow-up the patients, in addition to expertise in performing image-guided percutaneous spine procedures and resuscitation of compromised patients, qualifies the interventional pain physicians to become a leader in this field.

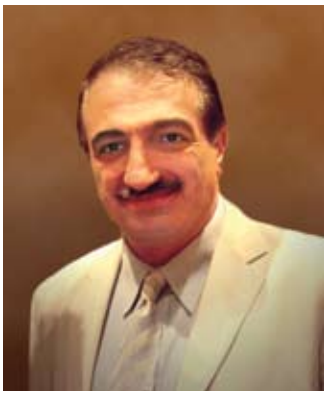
Typically occurring at the anterior third of the vertebral body where trabecular bone is less prominent, vertebral compression fractures alter the biomechanics of the spine making adjacent levels more vulnerable to fracture.

Vertebral compression fractures may also be secondary to tumor infiltration. The most frequent malignant lesions of the spine include osteolytic metastasis and myeloma. Although current cancer therapy prolongs life expectancy, there is an increase risk for these patients to develop metastatic vertebral involvement and collapse.

Gallibert, Deramond and colleagues in 1984 performed the first case of percutaneous vertebroplasty in France. Their first seven cases were reported in 1987. It wasn't until 1993 that Jensen and colleagues at the University of Virginia performed the first vertebroplasty in the United States. Since then it has gained widespread popularity, mostly because of significantly high rates of success, low incidence of complications, brief surgical time and recovery period, limited sedation, and short or no hospital stay.

Vertebroplasty involves use of acrylic bone cement to stabilize and treat painful vertebral compression fractures. The mechanism by which cement injection into the VCF produces pain relief remains unclear. Theories include thermal necrosis, chemotoxicity of the intraosseous pain receptors, mechanical stabilization, and neurotoxicity mediated by the cement monomer.[8,9]

Percutaneous vertebroplasty (PV) is performed by injection of polymethylmethacrylate cement into a fractured vertebral body via a needle that is placed percutaneously under image guidance (fluoroscopy and/or CT) by using a transpedicular or extra-pedicular approach. In the early years, the cement was injected in a semi-liquid state and under high pressure.[10] Because of the low viscosity injectates and the high injection pressures exerted while forcing the cement into the cancellous bone matrix, initially high incidences of cement extrusion were reported (38% to 73%).[11,12]



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Diagnosis

The most frequent clinical presentation is an elderly female with sudden onset of severe axial pain, which is exacerbated by weight bearing and alleviated by lying down. The presence of radicular symptoms, should cast doubt about the diagnosis, or to consider concomitant sources of pain. In our practice the examination of spine is performed in fluoroscopy suite with the patient in the prone position. Once tenderness is noted upon palpation of the spinous process of the suspected vertebral level, fluoroscopy is used to confirm the correlation between the fractured vertebra and pain provocation. If the patient does not complain of pain, it is very unlikely that this VBF is the source of pain.

During fluoroscopic examination we are also able to assess the feasibility of performing the procedure in a safe manner by evaluating the fluoroscopic view which at times could be made difficult due to severe osteoporosis and metallic wires from previous chest surgeries. In case of difficulty in achieving good fluoroscopic view, CT guidance will be used for safe needle placement while the injection of cement will be performed under real time fluoroscopy. Plain x-Rays are usually the first step in radiologic diagnosis of VCF but, the age and extent of VCF can be confirmed with MRI. A low signal in T1 and high signal in T2 weighted images reveals the presence of edema in the affected vertebral body, and if there is any doubt, fat suppressive images may rule out the presence of fat tissue into the vertebrae.

In case of contraindication for an MRI (Pacemakers, spinal cord stimulators, etc), a CT or bone scan may provide relevant information. CT scan will also be a valuable device in diagnosing the presence and severity of retropulsed bone fragments. Although not considered an absolute contraindication, the presence of retropulsion, will require extra vigilance, to avoid spinal compression at the time of cement injection.

Indications

Vertebroplasty is indicated for treatment of painful vertebral body fractures that are acute or subacute (as evidenced by T2-weighted MRI) resulting from osteoporosis, trauma and tumor infiltration.

Contraindications

1) Presence of pain with radicular symptoms that do not correspond to the area of the fracture; 2) More than 20% retropulsion of vertebral body fragment as evidenced by computed axial tomography (CT) or MRI; 3) Active localized or systemic infection; 4) Known allergy to PMMA (polymethylmethacrylate); 5) Uncorrected coagulopathy; 6) Painless compression fracture; 7) Complete vertebral collapse; 8) Epidural tumor; 9) Patient unable or unwilling to give informed consent.

Summary of procedure

Vertebroplasty is performed under complete sterile conditions and Monitored Anesthesia Care (MAC). Prophylactic antibiotics like Cefazolin 1 gm IV (or Clindamycin 600 mg IV in case of allergy) are administered 30 minutes prior to skin penetration. Appropriate padding during positioning is essential to avoid new osteoporotic fractures in areas like ribs. If possible, it is advocated to ask the patients to position themselves to avoid unrecognized pressure points.

Most of the times, a minimal dose of propofol at the time of local anesthetic injection for skin and subcutaneous tissues is the only anesthetic required and it allows a continuous interaction with the patient during the procedure. If the periostium is well anesthetized, the procedure is well tolerated by the patients and further sedation is not required. Vertebroplasty is most commonly performed by using a transpedicular approach but due to anatomical differences above T8 level a parapedicular approach is advocated. The target point for needle is the junction of anterior and middle third of the VB. There is still controversy over the advantage of using unipedicular (one needle) versus bipedicular approach and some recommend the bipedicular approach for the novice practitioners.[13] In general, if the initial needle is located close to the midline, there is no need to place a second one. Once the needle is correctly placed, the cement is prepared and then allowed to reach the consistency of a thin paste (e.g., like that of toothpaste) before injecting it slowly under real time continuous fluoroscopic guidance. Total amount to be injected varies according to the area. In the lumbar region a total of 3 to 6 milliliters are usually enough, while 2-3 milliliters are sufficient in the thoracic area. If there is any sign of cement extrusion or if it starts to move posteriorly in the vertebral body, the procedure should be immediately stopped and patient monitored closely. Total fluoroscopy time, using pulse mode, may range between 40 to 60 seconds per level and, use of protective gloves can reduce the radiation effect by 75%.[14]

Complications

The majority of complications are mild, transient and self-limited. Potential complications include hemorrhage, infection, spinal stenosis, pulmonary emboli; local trauma to nerve roots, spinal cord or kidney; and fracture of the lamina, pedicle or ribs.

Transient radiculopathy has been reported in 3%–6% of patients and has been successfully treated in the majority of cases with steroids and anti-inflammatory medications.[15]

Conventional PV is associated with a high incidence of cement extrusion (30%–80%), probably related to the low viscosity (used in the initial studies) and the high pressure required to inject cement into the cancellous matrix of the vertebral body[11,12] although this notion has been challenged by Tomita and colleagues.[16] There are many routes by which cement may leak from a vertebra: paravertebral, venous or into the spinal canal and intervertebral foramen.[17,18] Leakage into the paravertebral muscles can cause severe localized pain due to the exothermic reaction during cement curing and the effect of the mass of cement on muscle motion. Leakage of cement

(Vertebroplasty, continued on p. 24)

into the venous circulation can produce generalized toxic reactions and when entering the inferior vena cava, possibly life-threatening pulmonary embolization.[19-24] Leakage of cement into the epidural space may compress the spinal cord and/or nerve roots.[17,18,25-28] The incidence of this complication is low (1-2% of the cases) and they are usually self-limiting.

A post-operative CT scan is recommended if the physician suspects cement extrusion. A short course of oral steroids, anti-inflammatory medications or performing an epidural steroid injection is recommended and only in extreme cases decompressive laminotomy or foraminotomy may be required. Intradiscal cement extrusion is seen in 5-10% of the cases and the concern of increased risk of adjacent fractures is currently unsubstantiated. Rib fractures during conventional PV or Kyphoplasty® has been previously reported.[18]

Conclusion

Vertebroplasty, when performed by experienced practitioners, is a very effective and safe procedure and also one of the most rewarding interventional procedures. Vertebroplasty has been performed in hundreds of thousands of patients and if appropriately indicated, may result in almost complete pain relief, with resumption of daily living in 80 to 85% of the cases. As mentioned before, vertebroplasty is a minimally invasive procedure but maximally dangerous. Appropriate training and initial proctorship by an experienced practitioner could be a contributing factor to safety of the procedure. Although complication rate is very low, practitioners should be ready to manage life threatening complications, like anaphylactic reactions or potential devastating neurological sequelae.

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