The role of vertebroplasty in metastatic spinal disease

JULIE G. PILITSIS M.D., AND SETTI S. RENGACHARY, M.D.

Department of Neurological Surgery, Wayne State University, Detroit, Michigan

Many advances have been made in the treatment of metastatic spinal disease over the last few decades. Radiotherapy offers benefit and pain relief to many patients; however, this modality provides minimal vertebral stabilization. Surgical management consists of decompression and complex fusions. Vertebroplasty offers an adjuvant therapy to both radiotherapy and surgery by providing additional stabilization and pain relief. The results of case studies suggest that including vertebroplasty in the management of these patients is beneficial. In this article the authors review the role of vertebroplasty in metastatic spinal disease.

KEY WORDS • vertebroplasty • metastasis • spine • pain • analgesia • spinal fusion

Spinal metastases may result from nearly all malignancies, but the most frequent solid tumors spreading to the spine are breast, lung, or prostate carcinomas. Less frequently, renal, thyroid, or gastrointestinal carcinomas have been observed. The lymphoreticular malignancies, multiple myeloma and lymphoma, are also frequent causes of disseminated spinal lesions. Metastases account for 70% of all spinal tumors, and the lumbar spine is most frequently involved. Metastatic spinal lesions that cause severe back pain have a number of deleterious effects on the patient and may lead to impairment of functioning and of QOL. Furthermore, chronic pain often results in sleep loss, decreased mobility, and depression. Palliative treatment with bed rest, orthotics, NSAIDs, and narcotic medications has known complications. Radiotherapy provides significant pain relief but limited spinal stabilization. Vertebroplasty may be performed as a complement to radiotherapy to provide immediate pain relief and stabilization. In patients in whom surgery is contraindicated, vertebroplasty may be conducted to prevent further VB collapse and to improve pain relief. This article will describe the procedure and theoretical basis of vertebroplasty, the preoperative evaluation and indications for the procedure, and review studies in the literature in which this modality is used in the treatment of metastatic spinal disease.

VERTEBROPLASTY IN METASTATIC SPINAL DISEASE

Operative Technique

Vertebroplasty in which PMMA is used was developed in France in the late 1980s for the treatment of hemangiomas. Initial success with this procedure in hemangiomas has led to its use in the management of osteoporotic and osteolytic neoplastic lesions. Vertebroplasty is a minimally invasive procedure, the performance of which results in significant pain relief and spinal stabilization. The procedure is associated with limited complications.

The technique of vertebroplasty is described in various reviews. Briefly, the procedure is usually performed after the injection of a local anesthetic. The patient must be able to tolerate lying in the prone position for the duration of the intervention. Fluoroscopy and/or CT guidance must be used throughout the procedure. A vertebral puncture is initiated by an approach specific to the involved vertebral level, and once positioning has been verified, a radiograph is obtained. A biopsy sample should be acquired if the primary cancer is unknown and is in a pathological fracture suspicious for metastases. The PMMA is prepared and injected once proper consistency of the compound has been reached. Injection into both the lesion and normal VB is recommended. The entire lesion does not need to be filled because there is no relationship between the amount of the lesion is filled and subsequent pain relief. On the contrary, complete filling of the lesion leads to an increased risk of cement leakage. The total duration of the procedure is 1 to 2 hours.

Theoretical Basis of Vertebroplasty

The authors of cadaveric studies have demonstrated that vertebroplasty improves both the strength and stiffness of abnormal bone. In one ex vivo mechanical study on the effect of cement volume on the strength in osteoporotic VBs, the investigators demonstrated that strength was restored in both the thoracic and lumbar regions when cement volumes as low as 2 ml were injected. Both uni- and bilateral injections of bone cement significantly increase
forces.6 The destruction of nerve endings caused by the
biculation of microfractures and reduction of mechanical
the vertebroplasty-related analgesia is secondary to immo-
ocation and allowing a repair that enables healing.5
Furthermore, vertebroplasty of wedge fractures has been
shown to restore flexion-extension and lateral compli-
ance parameters to values similar to normal spine bio-
mechanics.31

Various theories on the procedure’s ability to provide
pain relief have been suggested. In cases of vertebral me-
tastases, local pain is thought to be secondary to bone frac-
tures and the reaction of the remaining nerve structures to
the tumor’s mass effect.30 It is likely that a component of
the vertebroplasty-related analgesia is secondary to immo-
obilization of microfractures and reduction of mechanical
forces.6 The destruction of nerve endings caused by the
cytotoxic, mechanical, and vascular effects of PMMA as
well as the thermal effects of polymerization, however,
may also play a role in pain relief.6,8,30 Furthermore, it has
been proposed that PMMA has an antitumoral effect,
which may explain the rarity of local recurrence after
vertebroplasty.6,30 This effect may be the result of the cy-
totoxicity, thermal effects, and ischemia produced by
PMMA.8,30 Analysis of pathological findings in patients in
whom PMMA has been injected has demonstrated a ma-
cro- and microscopic rim of tumor necrosis 6 months af-
after vertebroplasty/tumor injection, which seems to extend
outside the limits of the cement.27

Evaluation of Spinal Metastases

Patients with a suspected metastatic spinal lesion must
undergo a complete assessment including a physical, lab-
oratory, and radiographical evaluation to determine the
primary tumors in those in whom carcinoma was previ-
ously undiagnosed, and the extent of metastases must also
be investigated. In patients with an unknown primary car-
cinoma, physical examination, including breast and pros-
tate evaluations, should be performed. Routine laboratory
investigations, including complete blood count, electroly-
tes, serum calcium and phosphate levels, liver function
tests, serum prostate antigen (when indicated), and serum
protein electrophoresis, should be performed. Radiologi-
cal evaluation should include chest radiography, CT scan-
ning of the head, chest, abdomen, and pelvis, and mamm-
ography in women. At our institution, oncologists and
radiation oncologists are involved at an early stage to
guarantee that a multidisciplinary care approach is under-
taken. In patients in whom carcinoma has been diagnosed,
directed testing should be performed to determine whether
any additional metastases are present for prognostication.

Histological diagnosis of metastatic spinal lesions ob-
tained from a CT-guided biopsy sampling procedure in pa-
tients who have undergone this extensive battery of test-
ing will confirm clinical suspicion in the first biopsy
attempt in 86% of cases.15 In patients who are selected for
vertebroplasty, medical clearance is usually required be-
cause of coexisting medical conditions. In addition, a co-
agulation profile should be obtained, and a neurological
examination must be conducted to verify preexisting sen-
sory and/or motor abnormalities.

Indications for Vertebroplasty

The patient who may benefit most from vertebroplasty
has severe, localized, mechanical back pain related to ve-
tebra collapse in which there is no epidural involvement.3
The pain is constant, localized, debilitating, and often
worse at night.10 Attempts at achieving pain relief with
nonnarcotic analgesic agents, such as NSAIDs, should be
the first line of therapy. Narcotic analgesics in sustained-
release form should be administered if NSAIDs provided
no benefit. High-dose narcotics may result in somnolence,
mood changes, and impairment of function. Bed rest and
brace therapy are other common conservative treatment
modalities. It should be noted, however, that bed rest may
increase the likelihood of deep venous thrombosis in a
patient in whom there is already a predisposition to this
and may accelerate bone loss and muscle deconditioning.4
Brace therapy, such as the use of halo vests, although
often beneficial in patients with spinal instability and/or
pain, may impair QOL. Patients in whom medication and
bed rest have yielded limited pain relief or whose func-
tioning is significantly impaired by these measures should
be considered for vertebroplasty.

Vertebroplasty is also useful in patients with limited
anticipated survival, in poor surgical candidates, in those
who have received maximum radiation doses, and in those
with significant asymptomatic VB collapse secondary to
a lytic lesion.19,30 The success of vertebroplasty in cases of
metastatic disease has best been examined in the thora-
columbar region, although it may be used in the cervical
region when surgery is contraindicated.3 Vertebroplasty
should not be conducted in cases of spinal instability or
in patients with spinal cord compression or epidural tu-
mor extension who are surgical candidates.6,8 Pathological
fractures resulting in pain and/or neurological symptoms,
isolated metastases, radioresistant tumors, and relapse fol-
lowing maximum radiation doses may also be indications
for surgery.10,12,16,19,21 Vertebroplasty, however, may be
used as an adjuvant to surgical fusion and/or radiotherapy.

When vertebroplasty is performed in conjunction with
radiotherapy, most groups recommend that vertebroplasty
be undertaken prior to radiation treatment for best re-
sults.6,8,17 Murray, et al.,25 have demonstrated that radio-
therapeutic treatment of neoplasms is not affected by the
presence of cement, nor is cement affected by radiation.
In a study reported by Weill, et al.,30 however, all patients
in whom vertebroplasty was performed after radiotherapy
failed to resolve pain experienced clear or moderate im-
provement.

Contraindications for Vertebroplasty

Contraindications for vertebroplasty include the follow-
ing: a vertebra that has collapsed to less than one third of
its original height, coagulation disorders, a patient’s in-
ability to lie prone because of medical conditions, uncer-
tain cause of pain, and lack of immediate availability of
decompressive surgery.6,8,30 Lesions causing posterior wall
destruction are not an absolute contraindication to verte-
Vertebroplasty for spinal metastases

Vertebroplasty, although the occurrence of complications appears to be increased and may pose a greater risk in the thoracic or cervical levels.30

Primary Series on Vertebroplasty in Metastatic Spinal Disease

There are four series in the literature in which investigators specifically address the use of vertebroplasty in metastatic spinal disease, as well as a limited number of other case series that include this patient group in their cohort. Deramond, et al.,3 have reported their group’s experience in 101 patients with metastatic spinal disease. Significant improvements in pain relief and QOL were initially demonstrated in more than 80% of their patients.6 Long-term follow-up evaluation revealed that pain control lasted in two thirds of these patients.6 Cortet, et al.,3 have reported a decrease in pain within 48 hours of vertebroplasty in 97% of their 37 patients with osteolytic metastases or multiple myeloma; pain was completely absent in 13.5%, significantly reduced in 55%, and moderately reduced in 30%. Beneficial effects were seen in 89% at 3 months and 75% after 6 months. Their complication rate was 2 to 3%.5

Kaeberlen, et al.,17 have examined vertebroplasty as an adjuvant to radiotherapy in patients with painful osteolytic metastatic lesions. Of 20 patients with 33 treated VBs, pain relief occurred in 17 in less than 48 hours, with 14 patients requiring no analgesic medication and three requiring reduced dosages of medication. No change occurred in two patients, and signs of cord compression developed in the third. No pain recurrence was demonstrated in the cohort in a mean follow-up period of 2.8 months.

Weill, et al.,30 have reported a series in which they performed 40 procedures in patients with metastases. In 25 patients, vertebroplasty alone was performed. In three patients, vertebroplasty was combined with surgery, in 10 with radiotherapy, and in two with both surgery and radiotherapy. In the five patients who underwent both surgery and vertebroplasty, there was metastatic involvement of the facet joints. Both vertebroplasty and radiotherapy were performed in three patients when the cell type was determined to be radioresistant, and the lesion surpassed the cemented portion. In seven patients, vertebroplasty was conducted after radiotherapy failed to resolve symptoms. In 26 patients, chemotherapy was administered at the time of vertebroplasty.

In their study, Weill, et al.,30 defined clear pain improvement as a 50% reduction in pain medication or the replacement of narcotics with NSAIDs. Seventy-three percent had a clear improvement, 21% had a moderate improvement, and 6% had no improvement. In six of the seven patients with moderate improvement, three had extensive disease and three harbored multilacunar vertebral metastases, which are technically difficult to fill and result in leaks secondary to cortical erosion. Continued pain relief was estimated to be present in 73% of the population at 6 months and in 65% at 1 year. Patients with recurrent pain were noted to have new adjacent metastases and/or meningeal spread. In the subset of patients in whom vertebroplasty alone was performed, 74% had clear improvement, 22% had moderate improvement, and 4% had no improvement; in 76% persistent pain relief was demonstrated at 6 months.30

Barr, et al.,1 included eight patients with malignancy in their cohort of patients undergoing vertebroplasty. Their primary goal of treatment was to stabilize the vertebral column. Pain relief was achieved in 50% of their patients; however, these four patients suffered advanced disease and pain that was seemingly not well localized to the treated vertebra(e). Spinal stabilization, as assessed by radiographic and clinical examination, was achieved in seven of the eight patients.1

Procedure-Related Complications

The reported vertebroplasty-related complication rate in cases of metastatic disease is approximated at 10%.8 This rate is higher than that observed when vertebroplasty is used to treat patients with angioma or osteoporosis (2–5% and 1–3%, respectively) and may be a result of the increased VB destruction and/or poor general condition of the cancer patient. It is important to note, however, that the long-term complication rate in the patients with metastatic disease was 1.7%.8

Complications of the percutaneous approach are specific to the region of the spine in which surgery is performed. At the cervical level, the carotid artery and jugular vein may be injured. At the thoracic level, a pneumothorax and/or rib fracture are possible. In both the thoracic and lumbar levels, it is essential to maintain the integrity of the internal cortex of the pedicle to lessen the incidence of cement leakage. Use of smaller-gauge needles and adequate fluoroscopic/CT guidance may limit this complication.8 It should be mentioned that if a secondary approach to the same VB is attempted, the first needle must be left in place to prevent leakage.

Leakage of PMMA occurs during injection in up to 70 to 75% of patients; however, the vast majority of these leaks are clinically unimportant.58 Risk factors for leakage include posterior cortical wall destruction and epidural tumors.6 If extravasation into the paravertebral soft tissues or perivertebral veins occur, injection should be immediately halted.8 Venous leakage, especially into the inferior vena cava, has been reported to result in pulmonary embolism.24 Injection of the epidural or neuroforaminal veins or extravasation into the foramina may lead to radiculopathy, which is the major risk of this procedure.8

The majority of radicular symptoms are intercostal neuralgias that require local injection.6 Radicular symptoms in the lumbar level are usually resolved by steroid therapy, but they may occasionally require decompression for resolution.8 Locally increased pain may be secondary to an inflammatory reaction to PMMA itself when no leakage has occurred.30 Patients in whom this occurs are often managed with intravenous NSAIDs and steroids for 2 to 3 days, and excellent results have been reported.5 In rare cases, leakage may induce acute spinal cord compression, especially when the posterior wall of the VB is disrupted. It is important to perform vertebroplasty in a setting in which decompression may be performed immediately if required.

Prognosis After Vertebroplasty

Although no prospective randomized controlled studies...
have been published, the authors of numerous case studies have documented the efficacy of vertebroplasty in providing pain relief and improving mobility in patients with metastatic spinal disease. These studies have documented improvement of pain in 80 to 97% of patients within 48 hours of the procedure. Barr, et al., reported initial improvement in only 50% of their patients; however, their indication for vertebroplasty was spinal stabilization, and their patients did not specifically have pain localized in the treated VBs. Careful patient selection must be undertaken when pain relief is the goal, as in patients with advanced disease when the source of pain may not be limited to a given vertebral.¹

At 6-month follow up, 65 to 76% of patients in all studies experienced persistent pain relief. Both conventional fractionated and nonfractionated radiotherapy are associated with similar rates of pain control at 6 months.¹⁴,¹⁶ Pain relief following radiotherapy, however, is often delayed 10 to 20 days, and only minimal vertebral strengthening occurs. Unlike the delayed effects of radiotherapy, vertebroplasty provides immediate strengthening of the anterior column, which may limit painful VB collapse.¹ Furthermore, vertebroplasty provides early mobility, which limits complications related to inactivity. Increased mobility and pain relief lead to improvement of QOL for these patients. Vertebroplasty is complementary to both surgery and radiotherapy and should be considered as a treatment modality in patients with metastatic spinal disease.

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Manuscript received October 11, 2001. Accepted in final form November 2, 2001. Address reprint requests to: Julie G. Pilitsis, M.D., Department of Neurosurgery, Wayne State University, University Health Center Suite 6E, 4201 St. Antoine, Detroit, Michigan 48201. email: jgpilitsis@neurosurgery.wayne.edu.