### Clinical Condition: Management of Vertebral Compression Fractures

#### Variant 1:
Elderly woman with a recent recurring benign, painful 25% loss-of-height compression fracture. Previous fracture healed spontaneously with conservative management.

<table>
<thead>
<tr>
<th>Treatment/Procedure</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced radiologic imaging</td>
<td>6</td>
<td>A patient with a history of recurring pain may benefit from further imaging.</td>
</tr>
<tr>
<td>Conservative medical treatment</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Vertebroplasty</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Kyphoplasty</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Surgical referral</td>
<td>2</td>
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</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

#### Variant 2:
Elderly male with painful first spontaneous compression fracture who has limited his activities of daily living (ADLs). No neurologic symptoms are present.

<table>
<thead>
<tr>
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<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Advanced radiologic imaging</td>
<td>8</td>
<td>Significant information, such as the etiology of the fracture, can be obtained from cross-sectional imaging.</td>
</tr>
<tr>
<td>Conservative medical treatment</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Vertebroplasty</td>
<td>5</td>
<td>Use this procedure if the patient fails conservative management.</td>
</tr>
<tr>
<td>Kyphoplasty</td>
<td>5</td>
<td>Use this procedure if the patient fails conservative management.</td>
</tr>
<tr>
<td>Surgical referral</td>
<td>2</td>
<td></td>
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</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

#### Variant 3:
Middle-aged active man with a T7 burst fracture and a history of recent trauma. The new fracture is impeding his ADLs. Patient also complains of new-onset right lower limb tingling.

<table>
<thead>
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<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Advanced radiologic imaging</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Conservative medical treatment</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Vertebroplasty</td>
<td>3</td>
<td></td>
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<tr>
<td>Kyphoplasty</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Surgical referral</td>
<td>9</td>
<td>Given the neurologic complications, consider a surgical evaluation and MR imaging.</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate
**Clinical Condition:** Management of Vertebral Compression Fractures

**Variant 4:** Elderly female with painful subacute, hyperkyphotic compression fracture unresponsive to conservative treatment (NSAIDS) with continued loss of ADLs.

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<tr>
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</tr>
<tr>
<td>Conservative medical treatment</td>
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<td></td>
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<tr>
<td>Vertebroplasty</td>
<td>8</td>
<td></td>
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<tr>
<td>Kyphoplasty</td>
<td>7</td>
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<tr>
<td>Surgical referral</td>
<td>4</td>
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</tbody>
</table>

*Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate*

**Variant 5:** Elderly independent female with new painful fracture limiting ADLs and previous successful vertebroplasty.

<table>
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</thead>
<tbody>
<tr>
<td>Advanced radiologic imaging</td>
<td>8</td>
<td>Prior to intervention, perform imaging to rule out malignancy.</td>
</tr>
<tr>
<td>Conservative medical treatment</td>
<td>6</td>
<td></td>
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<tr>
<td>Vertebroplasty</td>
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<tr>
<td>Kyphoplasty</td>
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<td>Surgical referral</td>
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*Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate*

**Variant 6:** Elderly chronically bedridden man with a painful compression fracture that has failed conservative management.

<table>
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<td>Kyphoplasty</td>
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<tr>
<td>Surgical referral</td>
<td>3</td>
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*Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate*
Clinical Condition: Management of Vertebral Compression Fractures

Variant 7: Elderly female with malignant subacute, painful compression fracture refractory to conservative management.

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<td>Kyphoplasty</td>
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Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate
MANAGEMENT OF VERTEBRAL COMPRESSION FRACTURES

Expert Panels on Neurologic Imaging, Interventional Radiology and Musculoskeletal Imaging: Charles T. McConnell, Jr, MD; Franz J. Wippold II, MD; Charles E. Ray, Jr, MD, PhD; Barbara N. Weissman, MD; Peter D. Angevine, MD; Ian Blair Fries, MD; Langston T. Holly, MD; Baljendra S. Kapoor, MB, BS; Jonathan M. Lorenz, MD; Jonathan S. Luchs, MD; John E. O’Toole, MD; Nandini D. Patel, MD; Christopher J. Roth, MD; David A. Rubin, MD.

Summary of Literature Review

Introduction

Vertebral augmentation is a generic term referring to percutaneous vertebroplasty (VP) and balloon-assisted kyphoplasty [1]. They are procedures used for the palliation of pain related to vertebral compression fractures. Vertebral compression fractures can be caused by osteoporosis, direct acute trauma in an otherwise healthy vertebra, and neoplasms. Neoplasms causing vertebral compression fractures include: 1) primary bone neoplasms (hemangiomas, giant cell tumors), 2) infiltrative neoplasms (multiple myeloma, lymphoma), and 3) metastatic neoplasms [1-3]. Osteoporotic vertebral compression fractures are the most commonly encountered fractures that require augmentation and are the focus of this narrative.

Postmenopausal women represent the majority of patients at risk for developing osteoporotic fractures of any type, and vertebral compression fractures represent 25% of osteoporotic fractures [4-6]. Painful vertebral compression fractures may cause a marked decline in physical activity and quality of life, leading to general physical deconditioning. This, in turn, may prompt further complications related to poor inspiratory effort (atelectasis and pneumonia) and venous stasis (deep venous thrombosis and pulmonary embolism) [1]. Successful management of painful vertebral compression fractures has the potential for improving quality of life, increasing the expectancy of an independent and/or productive life, and preventing superimposed medical complications. Some have suggested that management of painful vertebral compression fractures may also have a cost benefit for society as a whole; however, assessment of any potential societal benefits is difficult due to the inexactness of methods for quantifying pain-related disability.

Management Overview

The traditional first-line treatment of painful vertebral compression fractures is conservative management, which includes medical management with or without methods of immobility [7]. Most pain-related symptoms from vertebral compression fractures are resolved with this management [7,8]. Successful medical management also involves appropriate screening for osteoporosis and appropriate follow-up treatment. (See the ACR Appropriateness Criteria® topic on “Osteoporosis and Bone Mineral Density.”) Vertebral augmentation in the form of VP and balloon-aided kyphoplasty has been used for managing painful vertebral compression fractures that are refractory to conservative management. The threshold for performing vertebral augmentation has declined due to expanded use within the medical community, the rapidity of clinical response, and the relatively low procedural risk. Indeed, some authors have advocated prophylactic VP [9,10]. In addition, there has been an increase in studies describing successful results using vertebral augmentation for painful refractory malignant fractures and symptomatic myelomatous vertebral replacement [11,12]. More invasive modifications, such as open kyphoplasty, have also been described for managing complex fractures that pose a relative contraindication for traditional VP. The increasingly widespread clinical applications and proposed indications for vertebral augmentation have fueled debate on the use, medical cost-effectiveness, and societal cost-effectiveness of these procedures.

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The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

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ACR Appropriateness Criteria®
Management Options

Conservative Management

Conservative management is the initial conventional treatment of painful vertebral compression fractures [7]. It includes medical management with or without methods of immobility. Medications include nonsteroidal anti-inflammatory drugs (NSAIDs) and narcotics. However, these medications have complications. Gastrointestinal hemorrhage, ulcerative perforations, and death occur in 1.5% of the patients annually, with 40% of chronic users having endoscopically proven ulcers [13,14]. Narcotics for noncancer pain management can lead to constipation (41%), nausea (32%), somnolence (29%), and addiction, with all patients exhibiting at least 1 adverse effect [15].

Most patients with osteoporotic vertebral compression fractures have spontaneous resolution of pain, even without medication [7,16-18]. Since the inception of vertebral augmentation in the late 1980s, its minimally invasive procedures have been reserved for patients who have failed conservative therapy. Failure can be defined as pain refractory to oral medications (NSAIDs and/or narcotics) [19-23]. However, failure can also be defined as a contraindication to such medications or a requirement for parenteral narcotics and hospital admission. A recent multispecialty Position Statement and the ACR Practice Guideline for the Performance of Vertebral Augmentation have addressed this topic [24,25].

Preprocedural Imaging

The ideal preprocedural imaging has not been identified [26,27]. For some authors, focal spinous process pain on palpation, correlated with radiographs of the vertebral column, is a satisfactory indication for the procedure. Spine radiographs, however, are often nonspecific with respect to the patient’s age or cause of the fracture [28]. Alternatively, others have recommended magnetic resonance imaging (MRI) prior to the procedure. MRI, especially using a short tau inversion recovery (STIR) sequence, is sensitive for detecting acute fractures and may differentiate synchronous fractures. MRI is also useful in distinguishing recent from chronic vertebral fractures in patients with multiple deformities and confusing clinical examinations [29,30]. Recent fractures exhibit edema, which can be detected by STIR MRI for up to 3 months after the fracture occurs [31,32]. Minimally deforming fractures that are overlooked by conventional radiographs but detected on MRI may be a cause of clinical failure of VP [26]. The benefits of MRI for preprocedural planning and guiding the puncture site have also been reported [26,33,34]. The use of MRI for evaluating benign and malignant fractures has also been well documented [35]. Thus, to ensure appropriate treatment, MRI evaluation should be considered prior to any planned vertebral augmentation in patients with a history of malignancy or atypical clinical features. The benefit of MRI must be weighed against its cost [27]. Computed tomography (CT) is usually reserved for a detailed analysis of fractures extending to the posterior column of the vertebra or for evaluating the integrity of pedicles and the posterior cortex prior to VP [2,36].

Percutaneous Vertebroplasty

Vertebral augmentation in the form of VP has been used for managing osteoporotic vertebral compression fractures since the 1980s in Europe and since the early 1990s in the United States. It involves injecting low-viscosity cement directly into the vertebral body, using a unipedicle or bipedicle needle. The procedure has had significant success, with 89%–93% of patients having reduced pain and pain-related morbidity and ≤40% having complete resolution of pain often immediately postprocedure [37,38]. This translates to improved ambulation (up to normal activity) in 56%–95% of patients [39-41]. Women and patients <75 years of age appear to benefit the most [41,42]. Kyphoplasty results largely parallel VP results, and the differences will be noted in later discussion.

With respect to pain relief, several studies have shown that VP reduces mean pain estimates based on a visual analogue scale (VAS scale range: 0–10) by approximately 5 points, with prevertebroplasty scores ranging from 8.1 to 8.4 and a reduced range of 2.6–3.0 postvertebroplasty [3,43-45]. The authors of this meta-analysis of 5 studies published a similar analysis of >1,400 patients; the mean VAS range was reduced from 5.4–9.1 to 1.5–4.9 [7,39,40,46,47]. Each study had a statistically significant (P<0.05) improvement in the VAS pain scale [7,39,40,46,47]. With respect to the duration of pain relief, it is well documented that vertebral augmentation is becoming more beneficial than conservative management, with respect to pain relief, quality of life, and mobility at all-time intervals between the day of procedure to ≥1 year [48]. The reported benefits of vertebral augmentation after 1 year, however, subside and show little different from patients who underwent conservative medical management [49-51].

However, controversy exists with respect to the overall benefit of VP, based largely on the conclusions of 2 high-profile, randomized control trials. These independent, prospective, randomized control trials compared VP with a
with or without neurological symptoms, as it may offer a more controlled angular and fracture correction with

Technically, kyphoplasty may have some merit for certain conditions, such as vertebral burst fractures

difference in outcome (based on results and complications), with the same type of complications occurring in both

with conventional VP [10]. Three studies that directly compared VP with kyphoplasty showed no significant

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of better deformity correction over VP. As with traditional VP, it can be achieved via a unipedicle (single balloon)

for a low-pressure injection of high-viscosity bone cement. Proponents of this procedure emphasize the benefits

insertion of a balloon dilation catheter which is then inflated to restore vertebral body height and create a space

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[38,65,70]. Technically, kyphoplasty may have some merit for certain conditions, such as vertebral burst fractures
with or without neurological symptoms, as it may offer a more controlled angular and fracture correction with
cement deposition when compared with VP alone [37,38,71]. In addition, some authors believe that kyphoplasty
is superior to conventional VP height restoration [37,38,71]. Due to space created by balloon dilation within the
vertebral body prior to injection, less cement leakage has also been noted for kyphoplasty when compared with

These results have stirred a debate between critics and supporters of the two studies [53]. Criticism has focused on
the scientific validity of the trials. These authors mostly criticize the relatively small sample size, the use of
lidocaine in the INVEST trial, and the high cross-over from the control group to the VP group, in addition to a
possible superimposed placebo effect [53]. This high cross-over may indicate patient dissatisfaction beyond the
placebo effect in the control group, and it may be compounded by the relatively small sample sizes [53]. An
additional caveat predicted by prior authors is that patients with significant pain, and those who are most likely to
respond significantly to VP, may also be reluctant to participate in a trial with a 50% chance of undergoing a
sham procedure [2]. Supporters of the findings of the 2 trials mention that these are the highest-level trials
investigating VP to date [53]. However, despite this controversy, use of vertebral augmentation procedures
increased from 2001 through 2008 [54].

The trend for increased use is likely attributable to individual physician experience on the efficacy of vertebral
augmentation as well as numerous and ever increasing alternative research studies showing its benefit. In
particular, the additional reported benefits of vertebral augmentation include vertebral deformity improvement,
improvement in activities of daily living (ADLs), and improved respiratory function and survival [55-59]. Also,
the rapidity of pain relief allowing for early mobilization after VP is often a reported benefit, especially in elderly
patients with limited life expectancy and treatment options [60,61]. There is also a growing body of evidence
supporting vertebral augmentation for refractory malignant fractures [11,12,62].

Although the reported complications ranged from only 1% to 3.9%, they varied depending on: 1) the specific
definitions of complications, 2) the degree of clinical and imaging follow-up, and 3) the collective definitions
(amalgamation) of complications. Frequently mentioned complications included: cement leak (asymptomatic or
symptomatic), cement pulmonary embolism (asymptomatic or symptomatic), and bleeding/hematoma, infection,
and neurological deficit (transient or permanent). Delayed complications included fractures involving other
vertebral levels in 2.5%–17.3% of cases (subject to the length and degree of follow-up, the definitions, and the
imaging quality), with 43%–49% and 51%–57% of these fractures occurring in distant or adjacent vertebral
bodies, respectively [38,39,52,63-66].

It is unknown whether additional fractures are truly long-term complications of the procedure (contributed in part
by the procedure) or the natural history and/or the progression of osteoporosis, and assessment is difficult without
prospective randomized trials involving large numbers of subjects [2]. Addressing the issue of additional fractures
in VP patients, Buchbinder et al [52] devised a randomized, controlled, prospective study in a small sample size.
In this study, patients were randomized to a VP group and a sham/placebo group. In a 6-month follow-up, 8.6%
(n=3 of 35) of the VP group and 11.1% (n=4 of 36) of the placebo group had secondary vertebral fractures. Other
studies reported repeat fractures in 27%–33% of patients following VP, with low body mass index, bone mineral
density, and vitamin D levels as contributing risk factors for additional fractures [67,68].
VP [72]. A recent study also suggested a small overall benefit of kyphoplasty over VP (and conservative management) with respect to life expectancy [73].

Open Kyphoplasty
Open kyphoplasty is the most invasive variant of vertebral augmentation. It involves using kyphoplasty with a surgical component that may include laminectomy, decompression, short-segment vertebral osteosynthesis, and/or short posterior internal fixation [47,74]. Fuentes et al. [74] disclosed a limited experience in 16 patients with neurological symptoms in which all showed improved symptoms and 88% had resolution of their symptoms. Another study of 21 patients showed that pain improved up to 3 months after the procedure and then reached a plateau [47]. This trend was also reflected by the percentage of patients who had residual disability of 88%, 35%, and 36% at 1, 3, and 12 months, respectively [47]. The experience with this procedure is limited and appears to be specific to trauma-related burst fractures, possibly in younger nonosteoporotic populations with neurological symptoms [47,74]. However, the use of hardware in the osteoporotic population can be difficult due the poor anchorage in weak osteoporotic vertebral bodies [1,2].

Summary
- Conservative management is the traditional first-line management for osteoporotic compression fractures.
- Controversy exists over the use of vertebral augmentation due to two previous independent level 1 trials that demonstrated no clinical validity for VP over the sham control groups. Conclusions from these studies have divided the medical community with respect to the efficacy of vertebral augmentation.
- Despite this controversy, increased use of vertebral augmentation for managing painful osteoporotic and malignant vertebral fractures has been the trend, with the literature favoring patient outcomes over conservative medical management up to 1 year.
- If VP is recommended for osteoporosis or malignant fractures, it should be used for patients who have failed or cannot tolerate conservative or traditional management.
- Kyphoplasty data are less extensive but have shown similar results to VP for uncomplicated vertebral compression fractures.
- Kyphoplasty may have an advantage over traditional VP in complex cases (eg, burst fractures with neurological compromise) or fractures in which height restoration or deformity correction may be beneficial. This slight mechanical advantage over VP may also affect long-term outcomes.
- More level 1 studies are needed to determine the medical and societal cost of the palliative effect on pain-related morbidity associated with osteoporotic vertebral compression fractures. Smaller sample studies and use trends indicate vertebral augmentation has benefits over conservative medical management for the first year.

Supporting Documents
For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

References


The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient’s clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient’s condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.