Vertebral Augmentation

Medical Policy #: 07.01.75
Original Effective Date: April 2017
Reviewed: April 2022
Revised: April 2022

NOTICE: This policy contains information which is clinical in nature. The policy is not medical advice. The information in this policy is used by Wellmark to make determinations whether medical treatment is covered under the terms of a Wellmark member's health benefit plan. Physicians and other health care providers are responsible for medical advice and treatment. If you have specific health care needs, you should consult an appropriate health care professional. If you would like to request an accessible version of this document, please contact customer service at 800-524-9242.

Benefit determinations are based on the applicable contract language in effect at the time the services were rendered. Exclusions, limitations, or exceptions may apply. Benefits may vary based on contract, and individual member benefits must be verified. Wellmark determines medical necessity only if the benefit exists and no contract exclusions are applicable. This medical policy may not apply to FEP. Benefits are determined by the Federal Employee Program.

This Medical Policy document describes the status of medical technology at the time the document was developed. Since that time, new technology may have emerged, or new medical literature may have been published. This Medical Policy will be reviewed regularly and be updated as scientific and medical literature becomes available; therefore, policies are subject to change without notice.

DESCRIPTION

Mechanical Vertebral Augmentation/Vertebral Body Stenting

Mechanical vertebral augmentation (e.g., Kiva®, SpineJack®, V-Strut®), also known as vertebral body stenting, is a technique that uses an implant for structural support of the vertebral body to provide a reservoir for bone cement. This technique is proposed to restore vertebral height and shape, providing support and symptomatic relief, and reduce the risk of cement leakage by formation of a cavity for cement application and to prevent the loss of correction that is seen following removal of the balloon used for balloon kyphoplasty. Mechanical kyphoplasty describes techniques which utilizes an expandable scaffold instead of a balloon to restore vertebral height.

Percutaneous Vertebroplasty

Percutaneous vertebroplasty is an interventional technique involving the fluoroscopically guided injection of polymethyl methacrylate (PMMA) or bone cement through a needle into a weakened vertebral body. The technique has been investigated to provide mechanical support and symptomatic relief in individuals with osteoporotic vertebral compression fractures or those with osteolytic lesions of the spine (e.g., multiple myeloma, metastatic malignancies).

Percutaneous Balloon Kyphoplasty
Percutaneous kyphoplasty/vertebral augmentation is a variant of vertebroplasty that is intended to restore the vertebral body height and alignment along with stabilizing the fracture. Balloon kyphoplasty involves the use of a specialized bone tamp with an inflatable balloon to expand a collapsed vertebral body. Bone cement or polymethyl methacrylate (PMMA) is then injected into the created cavity to stabilize the vertebral body.

Radiofrequency Vertebral Augmentation
Radiofrequency kyphoplasty (RFK), also known as radiofrequency-targeted vertebral augmentation, is a procedure intended as an alternative to a percutaneous balloon kyphoplasty. In a radiofrequency kyphoplasty, a surgeon uses a navigational cannula to create small pathways in the vertebra before injecting a proprietary ultra-high viscous bone cement, which is intended to restore height and alignment to the fractured vertebra, along with stabilizing the fracture. The surgeon uses radiofrequency heating pulses to control the cement's viscosity during injection; this in turn allows the surgeon to restore the vertebra's height with the injection alone, without the need for a balloon. The radiofrequency kyphoplasty procedure is also intended to preserve healthy tissue by creating smaller pathways in the vertebra than traditional percutaneous balloon kyphoplasty, reduce cement leak risks, and reduce procedure time. The surgeon mixes immediately before injection. The cement polymerizes as it passes through the radiofrequency heater.

Spineoplasty
Spineoplasty is a newer minimally invasive procedure similar to vertebroplasty currently being researched. The procedure includes a graft consisting of mesh filled with bone chips instead of the traditional cement used to fix a fracture. The OptiMesh® 1500E is a Polyethylene Terephthalate (PET) mesh pouch designed to contain impacted granular bone chips and allows it to be deployed to the area needing repair. This mesh graft is used most commonly for traumatic fracture repair and interbody fusion. This graft has not received FDA approval for this use.

Osteoporotic Vertebral Compression Fracture
Osteoporotic compression fractures are common. It is estimated that up to 50% of genotypic XX individuals and 25% of genotypic XY individuals will have a vertebral fracture at some point in their lives. However, only about one-third of vertebral fractures reach clinical diagnosis, and most symptomatic fractures will heal within a few weeks or one month. A minority of individuals will exhibit chronic pain following osteoporotic compression fracture that presents challenges for medical management.

Chronic symptoms do not tend to respond to the management strategies for acute pain such as bedrest, immobilization or bracing device, and analgesic medication, sometimes including narcotic analgesics. The source of chronic pain after vertebral compression fracture may not be from the vertebra itself but may be predominantly related to strain on muscles and ligaments secondary to kyphosis. This type of pain frequently is not

improved with analgesics and may be better addressed through exercise or physical therapy. Improvements in pain and ability to function are the principal outcomes of interest for treatment of osteoporotic fractures. Conventional vertebroplasty surgical intervention may be required in severe cases not responsive to conservative measures.

Osteolytic Vertebral Body Fractures
Vertebral body fractures can also be pathologic, due to osteolytic lesions, most commonly from metastatic tumors. Metastatic malignant disease involving the spine generally involves the vertebral bodies, with pain being the most frequent complaint.

While radiotherapy and chemotherapy are frequently effective in reducing tumor burden and associated symptoms, pain relief may be delayed days to weeks, depending on tumor response. Further, these approaches rely on bone remodeling to regain vertebral body strength, which may necessitate supportive bracing to minimize the risk of vertebral body collapse during healing.

Treatment of Sacral Insufficiency Fractures
Similar interventions are used for sacral and vertebral fractures and include bed rest, bracing, and analgesics. Initial clinical improvements may occur quickly; however, resolution of all symptoms may not occur for 9 to 12 months.

Vertebral and Sacral Body Metastasis
Metastatic malignant disease of the spine generally involves the vertebrae/sacrum, with pain being the most frequent complaint.

While radiotherapy and chemotherapy are frequently effective in reducing tumor burden and associated symptoms, pain relief may be delayed days to weeks, depending on tumor response. Further, these approaches rely on bone remodeling to regain strength in the vertebrae/sacrum, which may necessitate supportive bracing to minimize the risk of vertebral/sacral collapse during healing. Improvements in pain and function are the primary outcomes of interest for treatment of bone malignancy with percutaneous vertebroplasty or sacroplasty.

Surgical Treatment Options

1. **Percutaneous Vertebroplasty**
   Vertebroplasty is a surgical procedure that involves the injection of synthetic cement (e.g., polymethylmethacrylate, bis-glycidal dimethacrylate [Cortoss]) into a fractured vertebra. It has been suggested that vertebroplasty may provide an analgesic effect through mechanical stabilization of a fractured or otherwise weakened vertebral body. However, other mechanisms of effect have been postulated, including thermal damage to intraosseous nerve fibers.
2. **Percutaneous Sacroplasty**
   Sacroplasty evolved from the treatment of insufficiency fractures in the thoracic and lumbar vertebrae with vertebroplasty. The procedure, essentially identical to vertebroplasty, entails guided injection of polymethylmethacrylate through a needle

inserted into the fracture zone. Although first described in 2000 as a treatment for symptomatic sacral metastatic lesions, it is most often described as a minimally invasive alternative to conservative management, for sacral insufficiency fractures.

Pain and function are subjective outcomes and, thus, may be susceptible to placebo effects. Furthermore, the natural history of pain and disability associated with these conditions may vary. Therefore, controlled comparison studies would be valuable to demonstrate the clinical effectiveness of vertebroplasty and sacroplasty over and above any associated nonspecific or placebo effects and to demonstrate the effect of treatment compared with alternatives such as continued medical management.

In all clinical situations, adverse events related to complications from vertebroplasty and sacroplasty are the primary harms to be considered. Principal safety concerns relate to the incidence and consequences of leakage of the injected polymethyl methacrylate or another injectate.

Review of Evidence

Adverse Events

(2014) Yi et al. assessed the occurrence of new vertebral compression fractures after treatment with cement augmenting procedures (vertebroplasty or kyphoplasty) vs conservative treatment in an RCT with 290 patients (363 affected vertebrae). Surgically treated patients were discharged the next day. Patients treated conservatively (pain medication, bedrest, a body brace, physical therapy) had a mean length of stay of 13.7 days. Return to usual activity occurred at 1 week for 87.6% of surgically treated patients and 2 months for 59.2% of conservatively treated patients. All patients were evaluated with radiographs and magnetic resonance imaging at 6 months and then at yearly intervals until the last follow-up session. At a mean follow-up of 49.4 months (range, 36-80 months), 10.7% of patients had experienced 42 new symptomatic vertebral compression fractures. There was no significant difference in the incidence of new vertebral fractures between the operative (n=18; 9 adjacent, 9 nonadjacent) and conservative (n=24; 5 adjacent, 16 nonadjacent, 3 same level) groups, but the mean time to a new fracture was significantly shorter in the surgical group (9.7 months) compared with the nonoperative group (22.4 months).

Balloon Kyphoplasty Versus Conservative Care

(2009) Wardlaw et al. reported the Fracture Reduction Evaluation (FREE) trial, a nonblinded industry sponsored, multisite RCT in which 300 adults with 1 to 3 painful osteoporotic vertebral compression fractures of less than 3 months in duration. Twenty-four-month results were reported by Boonen et al (2011) and by Van Meirhaeghe et al. (2013). Scores for the primary outcome, 1-month change in the 36-Item Short-Form Health Survey Physical Component Summary score, were significantly higher for those in the kyphoplasty group. The difference between groups was 5.2 points (95% CI, 2.9 to 7.4 points; $p<0.001$). Kyphoplasty was associated with greater improvements in the 36-Item Short-Form Health Survey Physical Component Summary scores at 6-month follow-

up (3.39 points), but not at 12- or 24-month follow-ups. Greater improvement in back pain was observed over 24 months for kyphoplasty (-1.49 points) and remained statistically significant at 24 months. Participants in the kyphoplasty group also reported greater improvements in quality of life and Roland-Morris Disability Questionnaire scores at short-term follow-up. At 12 months, fewer kyphoplasty patients (26.4% vs 42.1%) had received physical therapy or walking aids, back braces, wheelchairs, miscellaneous aids, or other therapy. Fewer kyphoplasty patients used opioid medications through 6 months (29.8% vs 42.9%) and fewer pain medications through 12 months (51.7% vs. 68.3%). Other differences between groups were no longer apparent at 12 months, possibly due to natural healing of fractures.

Mechanical Vertebral Augmentation (e.g., Kiva or SpineJack) versus Balloon Kyphoplasty

(2019) Noriega et al. reported the pivotal multicenter non-inferiority trial of the SpineJack vertebral augmentation system. Patients (N =152) with osteoporotic vertebral compression fractures less than 3 months old were randomized to treatment with SpineJack or balloon kyphoplasty. The primary outcome was a composite measure that included improvement in visual analog scale for pain of greater than 20 mm, maintenance or improvement in Oswestry Disability Index, and lack of adverse events. Vertebral height was prespecified to be included if the primary outcome was achieved. Non-inferiority was achieved with 89.8% of SpineJack patients achieving the composite of clinical success compared to 87.3% for balloon kyphoplasty. When including the restoration of vertebral body height, the SpineJack procedure was found to be superior to balloon kyphoplasty at 6 months (88.1% vs. 60.9%) and at 12 months (79.7% vs. 59.3%, $p<0.001$). There was also a reduction in adjacent vertebral fractures with the mechanical augmentation system (12.9% vs. 27.3%; $p=0.043$). Interpretation of this study is limited by the lack of a sham control group. Limitations included: the patient-reported outcomes were not blinded. Radiographic assessments were blinded.

(2015) Tutton et al. completed an industry-sponsored, multicenter open-label Kiva Safety and Effectiveness Trial was conducted in 300 patients with 1 or 2 osteoporotic vertebral compression fractures. Included were patients with visual analog scale scores for back pain of at least 70 mm (/100 mm) after 2 to 6 weeks of conservative care or visual analog scale scores of at least 50 mm after 6 weeks of conservative care, and Oswestry Disability Index scores of at least 30%. The primary composite endpoint at 12 months was a reduction in fracture pain by at least 15 mm on the visual analog scale, maintenance or improvement in function on the Oswestry Disability Index, and absence of device-related serious adverse events. The primary endpoint was met by 94.5% of patients treated with Kiva and 97.6% of patients treated with kyphoplasty (Bayesian posterior probability of 99.92% for noninferiority, using as-treated analysis). In the 285 treated patients, Kiva resulted in a mean improvement of 70.8 points in visual analog scale scores, compared with a 71.8-point improvement for kyphoplasty. There was a 38.1-point improvement in Oswestry Disability Index score for the Kiva group compared with a 42.2-point improvement for the kyphoplasty group. There were no device-related serious adverse events. The total volume of cement was 50% less with Kiva, and there was less cement

extravasation (16.9%) compared with kyphoplasty (25.8%). Limitations include allocation was not concealed throughout the study; patients only blinded prior to procedure performance. The study was not powered for primary or secondary endpoints.

(2013) Korovessis et al. reported a randomized trial of 180 patients with osteoporotic vertebral compression fractures that compared mechanical vertebral augmentation with the Kiva device with balloon kyphoplasty in 180 patients with osteoporotic vertebral compression fractures. The groups showed similar improvements in visual analog scale scores for back pain, 36-Item Short-Form Health Survey scores, and Oswestry Disability Index scores. For example, there was a more than 5.5-point improvement in visual analog scale scores in 54% of patients in the Kiva group and 43% of patients in the balloon kyphoplasty group. Radiologic measures of vertebral height were similar in both groups. Kiva reduced the Gardner kyphotic angle, while residual kyphosis of more than 5° was more frequently observed in the balloon kyphoplasty group. Patients and outcome assessors were reported to be unaware of group assignments, although it is not clear if the Kiva device was visible on radiographs. Cement leakage into the canal only occurred in 2 patients treated with balloon kyphoplasty, necessitating decompression, compared with none following the Kiva procedure. Limitations included the study not being blinded.

Section Summary: Osteoporotic Vertebral Compression Fractures
A moderately sized unblinded RCT reported short-term benefits of kyphoplasty for pain and other outcomes in individuals with painful osteoporotic fractures compared with conservative care. A systematic review of RCTs found no significant difference in subsequent fracture between vertebroplasty and conservative treatment, and another systematic review of prospective and retrospective studies reported improved mortality with either vertebroplasty or balloon kyphoplasty compared with conservative treatment. Other relevant studies, including additional RCTs and meta-analysis studies, found similar outcomes for kyphoplasty and vertebroplasty.

For mechanical vertebral augmentation with Kiva and SpineJack, evidence includes industry-sponsored, multicenter investigational device exemption trials and a large independent randomized trial. These randomized comparative trials showed outcomes similar between Kiva and kyphoplasty. Mechanical vertebral augmentation with SpineJack was found to be non-inferior to balloon kyphoplasty for success on a composite outcome measure and superior to BK when vertebral height restoration was included in the composite. A major limitation of all these RCTs is the lack of a sham procedure. Due to the possible sham effect observed in the trials of vertebroplasty, the validity of the results from non-sham-controlled trials is unclear. Therefore, whether these improvements represent a true treatment effect is uncertain.

Osteolytic Vertebral Compression Fractures

Clinical Context and Therapy Purpose
The purpose of balloon kyphoplasty or mechanical vertebral augmentation (Kiva) is to provide a treatment option that is an alternative to or an improvement on existing

therapies, such as conservative care, in individuals with osteolytic vertebral compression fractures.

The question addressed in this evidence review is: Does the use of balloon kyphoplasty or mechanical vertebral augmentation improve the net health outcome for individuals who have osteoporotic vertebral compression fracture or osteolytic vertebral compression fractures?

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest are individuals with osteolytic vertebral compression fractures.

Interventions
The therapy being considered is balloon kyphoplasty or mechanical vertebral augmentation. The intervention involves the fluoroscopically guided injection of polymethyl methacrylate into a cavity created in the vertebral body with a balloon or mechanical device to provide support and symptomatic relief in individuals.

Comparators
Comparators of interest include conservative care. Treatment includes bed rest, local and systemic analgesia, and bracing, in a home setting as well as an outpatient clinical setting by a primary care provider.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, quality of life, hospitalizations, and treatment-related morbidity.

The existing literature evaluating balloon kyphoplasty or mechanical vertebral augmentation (Kiva) as a treatment for osteolytic occipital condyle fracture has varying lengths of follow-up. At least one year of follow-up for the primary outcome is necessary to adequately assess outcomes.

Systematic Reviews
(2016) Health Quality Ontario assessed vertebral augmentation for cancer-related vertebral compression fractures. The assessment identified 33 reports with 1,690 patients who were treated with kyphoplasty for spinal metastatic cancers, multiple myeloma, or hemangiomas. For cancer-related vertebral compression fractures there were 5 case series (110 patients) on multiple myeloma and 6 reports (2 RCTs, 4 case series; 308 patients) on mixed cancers with spinal metastases. Vertebral augmentation resulted in reductions in pain intensity scores, opioid or other analgesic use, and disability scores. One RCT (N =129) compared kyphoplasty with nonsurgical management for cancer-related vertebral compression fractures, reporting that pain scores, pain-related disability, and health-related quality of life were significantly improved in the kyphoplasty group than in the

usual care group. The second RCT compared the Kiva device with kyphoplasty in 47 patients with cancer-related compression fractures, finding no significant differences between groups for improvements in visual analog scale pain and Oswestry Disability Index scores.

(2014) Korovessis et al. compared efficacy of Kiva and kyphoplasty in an RCT with 47 participants with osteolytic vertebral compression fractures. Oswestry Disability Index scores improved by 42 and 43 points in the kyphoplasty and Kiva groups, respectively. Pain scores improved by 5.1 points in both groups, from baseline mean scores of 8.1 (kyphoplasty) and 8.3 (Kiva).

(2011) Berenson et al. reported the trial enrolled 134 patients with cancer who had at least 1 and not more than 3 painful osteolytic vertebral compression fractures. The primary outcome was change in functional status from baseline at 1 month as measured by the Roland-Morris Disability Questionnaire. Treatment allocation was not blinded, and the primary outcome at 1 month was analyzed using all participants with data both at baseline and at 1 month. Participants needed to have a pain score of at least 4, on a 0-to-10 scale. Crossover to the balloon kyphoplasty arm was allowed after 1 month. Reviewers reported scores for the kyphoplasty and nonsurgical groups of 17.6 and 18.2 at baseline, respectively, and 9.1 and 18.0 at 1-month follow-up (between-group difference in scores, $p<0.001$).

Section Summary: Osteolytic Vertebral Compression Fractures
Results of an RCT and case series suggest vertebral augmentation reduces pain, disability, and analgesic use in individuals with cancer-related compression fractures. However, because the results of the comparative studies of vertebroplasty have also suggested possible placebo effect, the evidence provided is insufficient to warrant conclusions about the effect of kyphoplasty on health outcomes

Osteoporotic Vertebral Compression Fractures

Clinical Context and Therapy Purpose
The purpose of balloon kyphoplasty or mechanical vertebral augmentation (e.g., Kiva) is to provide a treatment option that is an alternative to or an improvement on existing therapies in individuals with osteoporotic vertebral compression fractures.

The question addressed in this evidence review is: Does the use of balloon kyphoplasty or mechanical vertebral augmentation improve the net health outcome for individuals who have osteoporotic vertebral compression fracture?

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest are individuals with osteoporotic vertebral compression fracture.

Interventions
The therapy being considered is balloon kyphoplasty or mechanical vertebral augmentation. The intervention involves the fluoroscopically guided injection of polymethyl methacrylate into a cavity created in the vertebral body with a balloon or mechanical device to provide support and symptomatic relief in individuals.

Balloon kyphoplasty is a variant of vertebroplasty and uses a specialized bone tamp with an inflatable balloon to expand a collapsed vertebral body as close as possible to its natural height before injection of polymethyl methacrylate. Radiofrequency kyphoplasty (also known as radiofrequency targeted vertebral augmentation) is a modification of balloon kyphoplasty. In this procedure, a small diameter articulating osteotome creates paths across the vertebra. An ultra-high viscosity cement is injected into the fractured vertebral body, and radiofrequency is used to achieve the desired consistency of the cement. The ultra-high viscosity cement is designed to restore height and alignment to the fractured vertebra, along with stabilizing the fracture.

Kiva is another mechanical vertebral augmentation technique that uses an implant for structural support of the vertebral body to provide a reservoir for bone cement. The Kiva vertebral compression fractures Treatment System consists of a shaped memory coil and an implant, which is filled with bone cement. The coil is inserted into the vertebral body over a removable guide wire. The coil reconfigures itself into a stack of loops within the vertebral body and can be customized by changing the number of loops of the coil. The implant, made from PEEK-OPTIMA™, a biocompatible polymer, is deployed over the coil. The coil is then retracted, and polymethyl methacrylate is injected through the lumen of the implant. The polymethyl methacrylate cement flows through small slots in the center of the implant, which fixes the implant to the vertebral body and contains the polymethyl methacrylate in a cylindrical column. The proposed advantage of the Kiva system is a reduction in cement leakage.

SpineJack is a mechanical vertebral augmentation technique that utilizes bipedicular 4.2 mm to 5.0 mm self-expanding jacks to restore vertebral height. Placement of the titanium devices are verified in anteroposterior and lateral view prior to expansion. Once the devices are expanded, a proprietary bone cement is injected. The proposed benefit is greater control over expansion and greater restoration of vertebral height compared to balloon kyphoplasty. The procedure requires good bone quality.

Comparators
Comparators of interest include conservative care. Treatment includes bed rest, local and systemic analgesia, and bracing, in a home setting as well as an outpatient clinical setting. Conventional vertebroplasty procedures may also be used to treat this condition.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, quality of life, hospitalizations, and treatment-related morbidity. Kyphoplasty may also restore lost vertebral body height and reduce kyphotic deformity. Potential health outcomes related to

kyphotic deformity include pulmonary or gastrointestinal compression and associated symptoms, and vertebral compression fractures may be associated with lower health-related quality of life (e.g., European Quality of Life-5 Dimensions).

The existing literature evaluating balloon kyphoplasty or mechanical vertebral augmentation as a treatment for osteoporotic vertebral compression fractures has varying lengths of follow-up, ranging from one month to 4 years**.**

Kyphoplasty or Vertebroplasty versus Conservative Treatment
(2020) Hinde et al. performed a meta-analysis of 7 studies on the effect of vertebral augmentation (either vertebroplasty and/or balloon kyphoplasty) compared with nonsurgical management in over 1.5 million patients with osteoporotic vertebral compression fractures. Compared with nonsurgical management, vertebral augmentation reduced risk of mortality (hazard ratio [HR], 0.78; 95% CI, 0.66 to 0.92). These benefits remained significant in stratified analyses of mortality over periods of 2 years (HR, 0.70; 95% CI, 0.69 to 0.71) and 5 years (HR, 0.79; 95% CI, 0.62 to 1.00). Most studies were rated with scores of 7 to 9 on the Newcastle-Ottawa rating scale.

(2020) Sun et al. performed a meta-analysis of 32 studies (N=945) in patients with osteoporotic vertebral compression fracture treated with vertebral augmentation or conservative treatment. No significant differences were observed in the risk of clinical fracture (risk ratio [RR], 1.22; 95% CI, 0.70 to 2.12) or radiological fracture (RR, 0.91; 95% CI, 0.71 to 2.12). Overall, 10 studies were rated as high quality, and the remainder were rated as low quality. Results remained consistent when stratified by RCTs and non-RCTs.

(2018) Ong et al. evaluated the effect of the sham-controlled vertebroplasty trials on utilization of kyphoplasty/vertebroplasty, morbidity, and mortality in the Medicare population. 17,12,11, Using the complete inpatient/outpatient U.S. Medicare data set from 2005 to 2014, the investigators evaluated utilization of vertebral augmentation procedures in patients with osteoporotic vertebral compression fractures who were treated in the 5-year period before 2009 and those who were treated in the 5 years after the sham-controlled trials were published. Use of the 2 procedures peaked at 24% of the osteoporotic vertebral compression fracture population in 2007 to 2008, then declined to 14% of osteoporotic vertebral compression fracture patients in 2014. Compared to patients with osteoporotic vertebral compression fractures treated non-surgically, the kyphoplasty cohort (n=261,756) had a 19% (95% CI 19 to 19%) lower propensity-adjusted 10-year mortality risk. Compared to patients with osteoporotic vertebral compression fracture treated with vertebroplasty (n=117,232), the kyphoplasty cohort had a 13% (95% CI, 12 to 13%) lower propensity-adjusted 10-year mortality risk. The study also found that patients treated with non-surgical management were more likely to be discharged to nursing facilities. Although the analysis did adjust for possible confounding factors, the observational nature of the study precludes any inference of causality.

(2017) Zhao et al. completed a Bayesian network meta-analysis, examined the efficacy and safety of vertebroplasty, kyphoplasty, and conservative treatment for the treatment of osteoporotic vertebral compression fracture. Sixteen RCTs were identified (N =2,046 participants; vertebroplasty, 816; kyphoplasty, 478; conservative treatment, 752 conservative treatment). Eleven of the RCTs compared vertebroplasty with conservative treatment; 2 RCTs compared kyphoplasty with conservative treatment, and 3 RCTs compared kyphoplasty with vertebroplasty. Each trial assessed at least one of the following: visual analog scale, the Roland-Morris Disability Questionnaire, the European Quality of Life-5 Dimensions, and the observance of any new fractures. No significant difference was found between kyphoplasty and vertebroplasty for pain relief, daily function, and quality of life. Network meta-analysis demonstrated that kyphoplasty was superior to conservative therapy as assessed by visual analog scale (mean difference, 0.94; 95% confidence interval [CI], -0.40 to 2.39), European Quality of Life-5 Dimensions (mean difference -0.10; 95% CI, -0.17 to -0.01), and Roland-Morris Disability Questionnaire (mean difference, 5.72; 95% CI, 1.05 to 10.60). Insufficient data were present to complete pairwise comparison of kyphoplasty with conservative treatment for some metrics. Kyphoplasty was associated with the lowest risk of new fractures. This review was limited by significant heterogeneity across measured outcomes and length of follow-up in studies; the presence of performing and reporting bias in studies was also a concern.

(2011) Edidin et al. reported on mortality risk in Medicare patients who had osteoporotic vertebral compression fractures and had been treated with vertebroplasty, kyphoplasty, or nonoperatively. Using the U.S. Medicare dataset, the authors identified 85 8,978 patients who had vertebral compression fractures between 2005 and 2008. The dataset included 119,253 kyphoplasty patients and 63,693 vertebroplasty patients. Survival was calculated from the index diagnosis date until death or the end of follow-up (up to 4 years). Cox regression analysis was used to evaluate the joint effect of multiple covariates, which included sex, age, race/ethnicity, patient health status, type of diagnosed fracture, site of service, physician specialty, socioeconomic status, year of diagnosis, and census region. After adjusting for covariates, patients in the surgical cohorts (vertebroplasty or kyphoplasty) had a higher adjusted survival rate (60.8%) than patients in the nonsurgical cohort (50.0%) and were 37% less likely to die. The adjusted survival rates for vertebroplasty or kyphoplasty were 57.3% and 62.8%, respectively, a 23% lower relative risk for kyphoplasty. As noted by the authors, a causal relation could not be determined from this study.

Percutaneous Vertebroplasty for Vertebral Compression Fractures of Between 6 Weeks and 1 Year Old

Clinical Context and Therapy Purpose

Osteoporotic compression fractures are common. It is estimated that up to one-half of genotypic XX individuals and approximately one-quarter of genotypic XY individuals will have a vertebral fracture at some point in their lives. However, only about one-third of vertebral fractures reach clinical diagnosis, and most symptomatic fractures will heal

within a few weeks or one month with medical management. Nonetheless, some individuals with acute fractures will have severe pain and decreased function that interferes with the ability to ambulate and is not responsive to usual medical management. Also, a minority of individuals will exhibit chronic pain following osteoporotic compression fracture that presents challenges for medical management.

The purpose of vertebroplasty is to provide a treatment option that is an alternative to or an improvement on existing therapies in individuals with symptomatic osteoporotic or osteolytic vertebral fractures between 6 weeks and 1 year old.

The question addressed in this evidence review is: Does vertebroplasty improve the net health outcome in individuals with symptomatic osteoporotic or osteolytic vertebral fractures between 6 weeks and 1 year old?

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest is individuals with symptomatic osteoporotic or osteolytic vertebral fractures between 6 weeks and 1 year old. With acute fractures, these individuals experience severe pain, decreased ambulatory function, and a lessened response to conservative medical management. Risk factors for osteoporotic or osteolytic vertebral fractures can include osteopenia, osteoporosis, advanced age, inactivity, corticosteroid use, female sex, and depression.

Interventions
The therapy being considered is vertebroplasty, a procedure for stabilizing compression fractures in the spine, during which bone cement is injected into the fractured vertebra through a small hole in the skin in order to relieve back pain. The vertebroplasty procedure is performed in an outpatient setting by interventional radiologists or orthopedic surgeons.

Comparators
Comparators of interest include conservative management. Conservative management includes measures to reduce pain and improve mobility. Physical therapy, analgesics, narcotics, and hormone treatments can be prescribed to achieve this. Bed rest and braces may also be utilized as conservative management; however, these modalities are associated with prolonged immobilization which can further exacerbate bone loss and fail to relieve systems. Individuals who receive conservative management are typically managed by pediatricians, physical therapists, and primary care providers in an outpatient clinical setting.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, quality of life, hospitalizations, medication use, and treatment-related morbidity. Negative outcomes can include complications with sedation, further injury during transfer to the radiology table,

and the possibility of abuse after the prescription of narcotics. The outcomes of interest for vertebroplasty as a treatment for symptomatic vertebral fractures have varying follow-up times to fully examine the impact on the individuals, ranging from shorter term outcomes like medication use to outcomes that require extended follow-up, such as functional outcomes. Given that the existing literature evaluating vertebroplasty as a treatment for symptomatic vertebral fractures between 6 weeks and 1 year old has varying lengths of follow-up, ranging from 6 months to 2 years, follow-up timing of 1 year is appropriate to demonstrate efficacy.

Disability, a major factor on quality of life, is measured using various tools throughout the literature. Three such tools include the Roland-Morris Disability Questionnaire, the visual analogue scale, and QUALEFFO (a quality-of-life questionnaire in individuals with vertebral fractures).

- The Roland-Morris Disability Questionnaire is a self-administered disability measure in which greater levels of disability are reflected by higher numbers on a 24-point scale and on visual analogue scale. It has been shown to yield reliable measurements, which are valid for inferring the level of disability, and to be sensitive to change over time for groups of patients with low back pain.
- Visual analogue scale is commonly used as the outcome measure for such studies. It is usually presented as a 100-mm horizontal line on which the patient's pain intensity is represented by a point between the extremes of "no pain at all" and "worst pain imaginable."
- QUALEFFO (a quality-of-life questionnaire in patients with vertebral fractures), quality of life is measured by the scale 0 to 100, higher scores indicating worse quality of life.

Percutaneous Vertebroplasty for Vertebral Compression Fractures of Between 6 Weeks and 1 Year Old: Systematic Reviews

(2021) Chang et al. in a meta-analysis of RCTs and cohort studies, evaluated the effectiveness and safety of various interventions, including vertebroplasty versus kyphoplasty or conservative treatment, for treating osteoporotic vertebral compression fractures. Thirty-nine studies included vertebroplasty as a comparative arm. Outcomes included scores based on the visual analog scale and Oswestry Disability Index. Vertebroplasty decreased scores on the visual analog scale and Oswestry Disability Index compared with conservative treatment, but had similar outcomes compared with kyphoplasty. The rate of new fractures was similar for vertebroplasty versus conservative treatment and vertebroplasty versus kyphoplasty. Limitations consisted of the differences in indications, data types, follow-up times, and variables in included studies.

(2020) Hinde et al. in a meta-analysis of retrospective and prospective cohort studies, assessed the mortality outcomes of vertebral augmentation versus nonsurgical management in patients with osteoporotic vertebral compression fractures. The meta-analysis included 7 studies (N=2,089,944; 382,070 treated with vertebral augmentation and 1,707,874 treated with nonsurgical management). Vertebral augmentation improved mortality compared with nonsurgical management at both 2- and 5-year follow-up.

Limitations included heterogeneity in the number of enrolled patients in included studies as well as differences in health status.

(2020) Zhang et al. in a meta-analysis of RCTs, assessed the efficacy of percutaneous vertebroplasty versus conservative treatment for patients with osteoporotic vertebral compression fractures. Ten studies were included, and outcomes consisted of pain relief at 1 week, 1 month, and 6 months; quality of life assessments; and the rate of new vertebral fractures. Compared with conservative treatment, percutaneous vertebroplasty was superior for pain relief at 1 week and 1 month, but not at 3 months. Results varied for quality-of-life assessments with similar outcomes between percutaneous vertebroplasty and conservative treatments on the Roland-Morris Disability Questionnaire. Limitations included an imbalance in baseline demographics and the clinical characteristics of patients in included studies.

(2018) Buchbinder et al. published a Cochrane review of the literature up to November 2014. Studies compared vertebroplasty versus placebo (2 studies with 209 randomized participants), usual care (6 studies with 566 randomized participants), and kyphoplasty (4 studies with 545 randomized participants). Participants were Patients with osteoporotic vertebral fractures (mean age ranged from 63.3 to 80 years); symptom duration ranged from 1 week to >6 months. The majority of participants were female, between 63.3 and 80 years of age, with symptom duration ranging from 1 week to more than 6 months. At 1 month, disease-specific quality of life measured by the QUALEFFO (a quality-of-life questionnaire in patients with vertebral fractures; scale 0 to 100, higher scores indicating worse quality of life) was 0.40 points worse in the vertebroplasty group. Based upon moderate quality evidence from 3 trials (1 placebo, 2 usual care, 281 participants) with up to 12 months follow-up, it is unclear if vertebroplasty increases the risk of new symptomatic vertebral fractures. Similarly, based upon moderate quality evidence from 2 placebo-controlled trials, it is unclear to what extent risk of other adverse events exists. There were 3/106 adverse events observed in the vertebroplasty group compared with 3/103 in the placebo group; risk ratio, 1.01 (95% confidence interval [CI]: 0.21 to 4.85). Serious adverse events that have been reported with vertebroplasty included osteomyelitis, cord compression, thecal sac injury, and respiratory failure. The author's concluded high- to moderate-quality evidence that vertebroplasty has no important benefit in terms of pain, disability, quality of life or treatment success in the treatment of acute or subacute osteoporotic vertebral fractures in routine practice when compared with a sham procedure. Results were consistent across the studies irrespective of the average duration of pain. Sensitivity analyses confirmed that open trials comparing vertebroplasty with usual care are likely to have overestimated any benefit of vertebroplasty. Correcting for these biases would likely drive any benefits observed with vertebroplasty towards the null, in keeping with findings from the placebo-controlled trials. Numerous serious adverse events have been observed following vertebroplasty. However due to the small number of events, we cannot be certain about whether or not vertebroplasty results in a clinically important increased risk of new symptomatic vertebral fractures and/or other serious adverse events. Patients should be informed about both the high- to moderate-

quality evidence that shows no important benefit of vertebroplasty and its potential for harm.

(2017) Xie et al. in a meta-analysis of RCTs, evaluated the efficacy and safety in percutaneous vertebroplasty and conservative treatment for patients with osteoporotic vertebral compression fractures. Thirteen studies were selected (N =1231 patients; 623 to vertebroplasty, 608 to conservative treatment). Outcomes included pain relief (from 1 week to 6 months), quality of life assessments, and the rate of adjacent-level vertebral fracture. Vertebroplasty was superior for pain relief at 1 week and at 1 month. It was inferior to conservative treatment for pain relief at 6 months. Vertebroplasty showed improvement over conservative treatment for quality of life, as measured using the Quality-of-Life Questionnaire of the European Foundation for Osteoporosis. No statistically significant differences were found between treatments for the rate of adjacent-level vertebral fractures. Limitations included the inclusion of several studies with inadequate blinding and heterogenous reporting of patient characteristics outcomes.

(2011) Staples et al. conducted a patient-level meta-analysis of the 2 sham-controlled trials to determine whether vertebroplasty is more effective than sham in specific subsets of patients. This subset analysis focused on duration of pain (≤6 weeks vs. >6 weeks) and severity of pain (score <8 or ≥8 on an 11-point numeric rating scale). The analysis included 209 participants (78 from the Australian trial, 131 from the U.S. trial); 27% had pain of recent onset and 47% had severe pain at baseline. The primary outcome measures (pain scores and function on the Roland-Morris Disability Questionnaire at 1 month) did not differ significantly between groups. Responder analyses were also conducted based on a 3-unit improvement in pain scores, a 3-unit improvement in Roland-Morris Disability Questionnaire scores, and a 30% improvement in each of the pain and disability outcomes. The only difference observed between groups was a trend in the vertebroplasty group to achieve at least 30% improvement in pain scores (relative risk, 1.32; 95% CI, 0.98 to 1.76; p=0.07), a result that may have been confounded by the greater use of opioid medications in that group.

Percutaneous Vertebroplasty for Vertebral Compression Fractures of Between 6 Weeks and 1 Year Old: Randomized Controlled Trials: Vertebroplasty Versus Medical Management with Sham Controls

(2018) Firanescu et al. published the results of a randomized, double-blind, sham-controlled clinical trial performed in 4 community hospitals in the Netherlands from 2011 to 2015. The main outcome measured was mean reduction in visual analogue scale scores at 1 day, 1 week, and 1, 3, 6, and 12 months. The mean reduction in visual analogue scale score was statistically significant in the vertebroplasty and sham procedure groups at all follow-up points after the procedure compared with baseline. The percutaneous vertebroplasty intervention did not result in statistically significantly greater pain relief than a sham procedure during 12 months' follow-up among patients with acute osteoporotic vertebral compression fractures. (ClinicalTrials.gov NCT01200277.)

(2014) Chen et al. reported on a nonblinded RCT comparing vertebroplasty with conservative management. The trial included 89 patients with chronic compression fractures confirmed by magnetic resonance imaging and persistent severe pain for 3 months or longer. The evaluation was performed at 1 week and 1, 3, 6, and 12 months. Over the course of 1 year, pain scores decreased from 6.5 to 2.5 in the vertebroplasty group and from 6.4 to 4.1 in the control group ($p<0.001$). Complete pain relief was reported by 84.8% of patients in the vertebroplasty group and 34.9% of controls. The final Oswestry Disability Index score was 15.0 in the vertebroplasty group and 32.1 in the conservative management group ($p<0.001$), and the final Roland-Morris Disability Questionnaire score was 8.1 for vertebroplasty and 10.7 for controls ($p<0.001$). One reported limitation identified the study was not blinded.

(2014) Kroon et al. reported results of the same trial at 12 and 24 months, maintaining blinding throughout the follow-up period. The primary outcome was overall pain measured on a visual analogue scale from 0 to 10, with 1.5 points representing the minimal clinically important difference. For the primary outcome, reviewers reported no significant differences in visual analogue scale pain score at 3, 12, or 24 months. With reductions in pain and improvements in quality of life observed in both groups, the authors concluded routine use of vertebroplasty provided no benefit and the treatment in routine care is unsupported.

(2013) Comstock et al. reported on patient outcomes at 1 year, at which point 16% of patients who underwent vertebroplasty and 60% of control subjects had crossed over to the alternative procedure ($p<0.001$).27, The as-treated analysis found no significant difference in Roland-Morris Disability Questionnaire or pain scores between the 2 groups. Intention-to-treat analysis found a modest 1-point difference in pain rating and no significant difference in Roland-Morris Disability Questionnaire score. There was a significant difference in the percentage of patients showing a 30% or greater improvement in pain (70% of patients randomized to vertebroplasty vs. 45% of patients randomized to the control group). One limitation of this study is that at 14 days, 63% of patients in the control group correctly guessed they had the control intervention, and 51% of patients in the vertebroplasty group correctly guessed they had the vertebroplasty. The conclusions noted improvements in pain and pain-related disability associated with osteoporotic compression fractures in patients treated with vertebroplasty were similar to the improvements in a control group. (ClinicalTrials.gov number, NCT00068822.)

(2011) Farrokhi et al. reported on a blinded RCT that compared vertebroplasty with optimal medical management in 82 patients. Patients had painful osteoporotic vertebral compression fractures that were refractory to analgesic therapy for at least 4 weeks and less than 1 year. Control of pain and improvement in quality of life were measured by independent raters before treatment and at 1 week and 2, 6, 12, 24, and 36 months after treatment began. Radiologic evaluation to measure vertebral body height and correction of deformity was performed before and after treatment and after 36 months of follow-up. Adverse events include new symptomatic adjacent fractures in 1 patient in the treatment group and 6 in the control group. The authors found a statistically significant

improvement in pain in the PV group compared with the OMT group at 1 week (difference -3.1, 95% CI -3.72 to -2.28; $p < 0.001$). The QOL improved significantly in the PV group (difference -14, 95% CI -15 to -12.82; $p < 0.028$). One week after PV, the average VBH restoration was 8 mm, and the correction of deformity was 8°. The incidence of new fractures in the OMT group (13.3%) was higher than in the PV group (2.2%; $p < 0.01$). Additionally, 1 patient experienced epidural cement leakage, which caused severe lower extremity pain and weakness, and had to be treated with bilateral laminectomy and evacuation of the bone cement. In conclusion, the PV group had statistically significant improvements in visual analog scale and QOL scores maintained over 24 months, improved VBH maintained over 36 months, and fewer adjacent-level fractures compared with the OMT group.

(2009) Kallmes et al. conducted a multicenter, randomized, double-blind, sham controlled, Investigational Vertebroplasty Safety and Efficacy Trial in which 131 participants with 1 to 3 painful osteoporotic vertebral fractures were assigned to vertebroplasty or sham procedure (injection of local anesthetic into the facet capsule and/or periosteum). Participants had back pain for no more than 12 months and had a current pain rating of at least 3 on visual analogue scale at baseline. Participants were evaluated at various time points to 1 year post procedure. Ninety-seven percent completed a 1-month follow-up; 95% completed 3 months. The primary outcomes were Roland-Morris Disability Questionnaire scores and average back pain intensity during the preceding 24 hours at 1 month, with a reduction of 30% in Roland-Morris Disability Questionnaire and visual analogue scale pain scores considered a clinically meaningful difference. Conclusions noted improvements in pain and pain-related disability associated with osteoporotic compression fractures in patients treated with vertebroplasty were similar to the improvements in a control group. (ClinicalTrials.gov number, NCT00068822).

(2009) Buchbinder et al. reported on results for a 4-center, randomized, double-blind, sham-controlled trial with 78 patients with 1 or 2 painful osteoporotic vertebral fractures with a duration of less than 1 year. Patients were assigned to vertebroplasty or sham procedure (i.e., injection of local anesthetic into the facet capsule and/or periosteum). Ninety-one percent of participants completed 6 months of follow-up. The participants, investigators (other than the radiologists performing the procedure), and outcome assessors were blinded to the treatment assignment. A total of 78 participants were enrolled, and 71 (35 of 38 in the vertebroplasty group and 36 of 40 in the placebo group) completed the 6-month follow-up (91%). Vertebroplasty did not result in a significant advantage in any measured outcome at any time point. There were significant reductions in overall pain in both study groups at each follow-up assessment. At 3 months, the mean (+/-SD) reductions in the score for pain in the vertebroplasty and control groups were 2.6+/-2.9 and 1.9+/-3.3, respectively (adjusted between-group difference, 0.6; 95% confidence interval, -0.7 to 1.8). Similar improvements were seen in both groups with respect to pain at night and at rest, physical functioning, quality of life, and perceived improvement. Seven incident vertebral fractures (three in the vertebroplasty group and four in the placebo group) occurred during the 6-month follow-up period. The authors

concluded they found no beneficial effect of vertebroplasty as compared with a sham procedure in patients with painful osteoporotic vertebral fractures, at 1 week or at 1, 3, or 6 months after treatment. (Australian New Zealand Clinical Trials Registry number, ACTRN012605000079640.)

Percutaneous Vertebroplasty for Vertebral Compression Fractures of Between 6 Weeks and 1 Year Old: Nonrandomized Comparative Studies

(2017) Lin et al. reported on mortality risk in elderly patients (>70 years old) who had vertebral compression fractures and were treated with early vertebroplasty (within 3 months) or conservative therapy. The data set consisted of 10,785 Taiwanese patients who were selected through the National Health Insurance Research Database, of whom 1,773 patients received vertebroplasty, and 5,324 did not; a minority of these patients had osteoarthritis. The authors found that a "significant difference in survival curves of mortality and respiratory failure" existed between both groups of patients ($p<0.05$). The incidence of death at 1 year in the vertebroplasty group was 0.46 per 100 person-months (95% CI, 0.38 to 0.56). The incidence of death at 1 year in the nonvertebroplasty group was 0.63 per 100 person-months (95% CI, 0.57 to 0.70). With regard to respiratory failure, hazard ratio between groups was 1.46 (95% CI, 1.04 to 2.05; $p=0.028$). Limitations of this study included the broad selection of the population, which was not restricted only to patients with osteoporotic lesions. Also, authors were limited by the database, which did not report on pain or functional outcomes.

(2015, 2011) Edidin et al. reported on mortality risk rates in Medicare patients who had vertebral compression fractures and were treated with vertebroplasty, kyphoplasty, or nonoperatively., These studies were industry funded. In the 2015 report, they identified 1,038,956 patients who had vertebral compression fractures between 2005 and 2009. The dataset included 141,343 kyphoplasty patients and 75,364 vertebroplasty patients. The matched cohort included 100,649 nonoperated patients, 36,657 kyphoplasty patients, and 24,313 vertebroplasty patients. Survival was calculated from the index diagnosis date until death or the end of follow-up (up to 4 years). Analysis of the whole data set before matching indicated that patients in the nonoperated cohort had a 55% (95% CI, 53% to 56%; $p<0.001$) higher risk of mortality than the kyphoplasty cohort and a 25% (95% CI, 23% to 26%; $p<0.001$) higher mortality risk than the vertebroplasty cohort. After propensity matching, the risk of mortality at 4 years was 47.2% in the nonoperated group compared with 42.3% in the kyphoplasty group ($p<0.001$) and 46.2% in the vertebroplasty group ($p<0.001$).

Section Summary: Percutaneous Vertebroplasty for Vertebral Compression Fractures of Between 6 Weeks and 1 Year Old

Despite evidence from numerous RCTs, including several with sham controls, the efficacy of vertebroplasty for painful osteoporotic compression fractures of less than 1 year remains uncertain. Meta-analysis studies have been published, but they have numerous limitations due to heterogeneity of included studies. Another major limitation to several meta-analyses is that they do not specify the timeframe for osteoporotic vertebral compression fractures. There remains some uncertainty related to the

interpretation of these conclusions. While the use of a sham procedure is a major methodologic strength to control for nonspecific (placebo) effects, the sham used is controversial, given that the effect of injecting local anesthetic in the facet capsule and/or periosteum is unknown. Additionally, the appropriateness of outcome measures used to detect clinically meaningful differences in pain might not have been optimal, because the studies were underpowered to detect differences in clinical response rates. Questions have also been raised about the low percentage of individuals screened who participated in the trial, the volume of polymethylmethacrylate injected, and the inclusion of individuals with chronic pain.

Percutaneous Vertebroplasty for Vertebral Compression Fractures of Less Than 6 Weeks Old

Clinical Context and Therapy Purpose
The purpose of vertebroplasty is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as conservative management, in patients with symptomatic osteoporotic vertebral fractures less than 6 weeks old.

The question addressed in this evidence review is: Does vertebroplasty improve the net health outcome in individuals with symptomatic osteolytic vertebral fractures less than 6 weeks old?

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest is individuals with symptomatic osteoporotic vertebral fractures less than 6 weeks old. With acute fractures, these individuals experience severe pain, decreased ambulatory function, and a lessened response to conservative medical management.

Interventions
The therapy being considered is vertebroplasty, which is typically performed by an interventional radiologist in an outpatient clinical setting.

Comparators
Comparators of interest include conservative management. A detailed review of the comparators is listed in the above indication. Individuals receiving conservative management are typically managed by physical therapists and primary care providers in an outpatient clinical setting.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, quality of life, hospitalizations, medication use, and treatment-related morbidity. Symptoms can include back pain and demonstrated fracture on radiography. The most current research available tracks follow-up to 12 months or more. A number of studies have longer term follow-up

at more than 5 years, which is ideal for understanding all of the outcomes, particularly the occurrence of new vertebral compression fractures after vertebroplasty.

Percutaneous Vertebroplasty for Vertebral Compression Fractures of Less Than 6 Weeks Old: Randomized Controlled Trials (RCT): Vertebroplasty versus Medical Management

(2016) Clark et al. reported on results from the Safety and Efficacy of Vertebroplasty of Acute Painful Osteoporotic Fractures (VAPOUR) trial. VAPOUR was a multicenter, double-blind trial of vertebroplasty in 120 patients with vertebral fractures of less than 6 weeks in duration and back pain of at least 7 out of 10 on a numeric rating scale. Between Nov 4, 2011, and Dec 5, 2014, 120 patients were enrolled. 61 patients were randomly assigned to vertebroplasty and 59 to placebo. 24 (44%) patients in the vertebroplasty group and 12 (21%) in the control group had an NRS pain score below 4 out of 10 at 14 days (between-group difference 23 percentage points, 95% CI 6-39; p=0·011). Three patients in each group died from causes judged unrelated to the procedure. There were two serious adverse events in each group, related to the procedure (vertebroplasty group) and the fracture (control group). In conclusion, vertebroplasty is superior to placebo intervention for pain reduction in patients with acute osteoporotic spinal fractures of less than 6 weeks in duration. These findings will allow patients with acute painful fractures to have an additional means of pain management that is known to be effective.

(2016) Leali et al. published a brief report on a multicenter RCT enrolling 400 patients with osteoporotic thoracic or lumbar vertebral compression fractures who were treated with vertebroplasty or conservative therapy and were postmenopausal women. Fractures were treated within 2 weeks of pain onset. Details of randomization and rates of follow-up were not reported. At 1 day after treatment, the vertebroplasty group had a reduction in pain scores and improvement in physical function, with visual analogue scale pain scores decreasing from 4.8 (maximum, 5.0) to 2.3 (p=0.023) and Oswestry Disability Index scores improving from 53.6% to 31.7% (p=0.012). Sixty-five percent of patients treated with vertebroplasty had stopped all analgesic use within 48 hours. The conservatively managed group showed no benefit in the first 48 hours, but by 6 weeks visual analogue scale and Oswestry Disability Index scores were described as similar in both groups (specific data not reported). Evaluation of this trial was limited by incomplete reporting. It is unclear is masking occurred and outcomes beyond 48 hours post-surgery were not reported. In conclusion, 200 patients treated with PV compared with 200 patients treated conservatively had significantly better VAS and used less analgesics 1 day after treatment. Twenty-four hours after VP, there was a reduction in pain scores and an improvement in physical functions, whereas remain unchanged in the patients treated conservatively. Pain relief and improvement of mobility and function after PV is immediate and significantly better in the short-term compared with non-surgical care treatment.

(2016) Yang et al. compared vertebroplasty with conservative therapy in 135 patients over 70 years of age with severe back pain due to an osteoporotic vertebral fracture after minor or mild trauma. Vertebroplasty was performed at a mean of 8.4 days after pain

onset. Patients in the conservative therapy group were placed on bed rest and analgesics for at least 2 weeks after diagnosis, followed by bracing and assistive devices. All patients receiving vertebroplasty could stand and walk with a brace at 1 day posttreatment, while only 12 (23.5%) patients in the control group could stand up and walk after 2 weeks of bed rest. The average duration of bed rest from pain onset was 7.8 days (range, 2-15 days) in the vertebroplasty group compared with 32.5 days (range, 14-60 days) in the conservative therapy group. At 1-year follow-up, there was a similar percentage of additional compression fractures but a significantly higher complication rate in the conservative therapy group (35.3%) than in the vertebroplasty group (16.1%; $p<0.001$). Complications included pneumonia, urinary tract infection, deep vein thrombosis, depression, and sleep disorders. Limitations noted were the study population limited to > 70 years of age at single spine center and there was no masking. The author's concluded, in aged patients with acute OVCF and severe pain, early vertebroplasty yielded faster, better pain relief and improved functional outcomes, which were maintained for 1 year. Furthermore, it showed fewer complications than conservative treatment.

(2014) Yi et al. assessed the occurrence of new vertebral compression fractures after treatment with cement augmenting procedures (vertebroplasty or kyphoplasty) versus conservative treatment in an RCT with 290 patients (363 affected vertebrae). Patients treated conservatively had a mean length of stay of 13.7 days. Return to usual activity occurred at 1 week for 87.6% of operatively treated patients and 2 months for 59.2% of conservatively treated patients. All patients were evaluated with radiographs and magnetic resonance imaging at 6 months and then at yearly intervals until the last follow-up session. At a mean follow-up of 49.4 months (range, 36-80 months), 10.7% of patients had experienced 42 new symptomatic vertebral compression fractures. There was no significant difference in the incidence of new vertebral fractures between the operative (18 total; 9 adjacent, 9 nonadjacent) and conservative (24 total; 5 adjacent, 16 nonadjacent, 3 same level) groups but the mean time to a new fracture was significantly shorter in the operative group (9.7 months) than in the nonoperative group (22.4 months). In conclusion, patients who had experienced PVP/PKP were not associated with an increased risk of recompression in new levels. However, recompression in new levels of PVP/PKP group occurred much sooner than that of conservative group in the follow-up period. The incidence of new vertebral fractures observed at adjacent levels was substantially higher but no sooner than at distant levels in PVP/PKP group. No major risk factors involving new OVCFs have been found in this study and augmentation for sandwich situation is not necessary. It should be noted selection criteria for PVP or PKP unclear, some patients had > fracture.

(2010) Klazen et al. reported on the Vertebroplasty versus Conservative Treatment in Acute Osteoporotic Vertebral Compression Fractures, an open-label randomized trial of 202 patients at 6 hospitals in the Netherlands and Belgium. Of 431 patients eligible for randomization, 229 (53%) had spontaneous pain relief during assessment. Participants with at least 1 painful osteoporotic vertebral fracture of 6 weeks or less in duration were assigned to vertebroplasty or conservative management. The primary outcome was pain

relief of 3 points measured on a 10-point visual analogue scale at 1 month and 1 year. A total of 101 subjects were enrolled in the treatment group and the control arm; 81% completed 12-month follow-up. There were no significant differences in the primary outcome (pain relief of 3 points) measured at 1 month and 1 year. Vertebroplasty resulted in greater pain relief than did medical management through 12 months (<0.001); there were significant between-group differences in mean visual analogue scale scores at 1 month or at 1 year. Survival analysis showed significant pain relief was quicker (29.7 days vs. 115.6 days) and was achieved by more patients after vertebroplasty than after conservative management. In conclusion, within a subgroup of patients with acute osteoporotic vertebral compression fractures and persistent pain, percutaneous vertebroplasty is effective and safe. Pain relief after vertebroplasty is immediate, is sustained for at least a year, and is significantly greater than that achieved with conservative treatment, at an acceptable cost.

Section Summary: Percutaneous Vertebroplasty for Vertebral Compression Fractures of Less Than 6 Weeks Old
In a sham-controlled randomized trial, where no anesthetic was injected into the periosteum, there was a significant benefit of vertebroplasty in individuals who had severe pain of fewer than 6 weeks in duration following vertebral fracture at the thoracolumbar junction. Other RCTs without sham controls have reported that vertebroplasty is associated with significant improvements in pain, earlier improvements in function, and reductions in the duration of bed rest compared with conservatively managed individuals.

Percutaneous Sacroplasty

Clinical Context and Therapy Purpose
Sacral insufficiency fractures are the consequence of stress on weakened bone and often cause low back pain in the elderly population. Osteoporosis is the most common risk factor for sacral insufficiency fractures. Lourie (1982) described spontaneous fracture of the sacrum in individuals with osteoporosis as presenting as lower back and buttock pain with or without referred pain in the legs. Although common, sacral insufficiency fractures can escape detection due to low provider suspicion and poor sensitivity on plain radiographs, slowing the application of appropriate intervention.

The purpose of sacroplasty is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as conservative management, in individuals with sacral insufficiency fractures.

The question addressed in this evidence review is: Does sacroplasty improve the net health outcome in individuals with sacral insufficiency fractures?

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest is individuals with sacral insufficiency fractures. Sacral insufficiency fractures are a stress fracture, resulting from a regular stress applied to a bone with reduced elasticity. Often, these fractures are associated with underlying metabolic bone disease condition like osteoporosis. Examples of risk factors include corticosteroid therapy use, female sex, pelvic radiation, rheumatoid arthritis, and hyperparathyroidism.

Interventions
The therapy being considered is sacroplasty, a minimally invasive procedure for treating pathological fractures of the sacral vertebral body or sacral ala. The procedure involves percutaneous insertion of 1 or more bone needles into the sacrum and injection of bone cement under fluoroscopy and/or computed tomography visual guidance. This intervention is provided by an interventional radiologist typically in an outpatient setting.

Comparators
Comparators of interest include conservative management. Conservative management includes physical therapy, analgesics, narcotics, and hormone treatments. Examples of conservative management for sacral insufficiency fractures are varied and can include bed rest and pain medication to early physical therapy. Sacral insufficiency fractures are managed by orthopedists and physical therapists.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, quality of life, hospitalizations, medication use, and treatment-related morbidity. Possible negative outcomes include complications with sedation, cement leakage into the presacral space, spinal canal, sacral foramen, or sacroiliac joint, and possible spinal compression due to extravasation of cement. At least 1 year of follow-up is desirable to adequately evaluate outcomes.

Percutaneous Sacroplasty: Observational Studies
Sacroplasty is an evolving technique achieved using numerous methods (short-axis, long-axis, balloon-assisted short-axis, iliosacral screws).

(2017) Frey et al. reported on patients treated with percutaneous sacroplasty, particularly the long-term efficacy of sacroplasty versus nonsurgical management, this prospective, observational cohort study spanned 10 years and comprised 240 patients with sacral insufficiency fractures. Thirty-four patients were treated with nonsurgical methods, and 210 patients were treated with sacroplasty. Pain, as measured by visual analogue scale, was recorded before treatment and at several follow-ups. Results: both NSM and sacroplasty resulted in statistically significant drops in visual analog scale (VAS) scores from pre-treatment to 2-year follow-up ($P < 0.001$). When measured from follow-up to follow-up, the NSM group's only significant decrease in the mean VAS score was between pre-treatment and 2 weeks ($P = 0.002$). The experimental group had significant decreases over the periods pre-op through post-op ($P < 0.001$), post-op through 2 weeks

(P < 0.001), 12 weeks through 24 weeks (P = 0.014), and 24 weeks through one year (P = 0.002). The experimental cohort experienced statistically significant drops in the mean VAS scores between follow-ups for a longer period of time. Opioid and non-opioid analgesic use was markedly decreased preoperatively to postoperatively and was sustained at the 10-year follow-up. Limitations were noted as follows: Patients were placed into the control group, NSM, if they did not meet inclusion criteria for sacroplasty. However, the baseline characteristics of the sacroplasty versus NSM group were not statistically different. Additionally, the control group was only followed through 2 years and was not contacted at the 10-year follow-up. In conclusion, our results and those reported in previous studies establish that sacroplasty allows for decreased use of medications and results in pain relief, greater patient mobility, and improved patient satisfaction. In addition to the published body of literature, our results show strong evidence in support of sacroplasty as a safe and efficacious treatment of SIFs.

(2014) Dougherty et al. described a series of 57 patients treated with sacroplasty for sacral insufficiency fractures. The short- or the long-axis approach was dictated by the length and type of the fracture and patient anatomy. Follow-up data at 2.5 weeks were available for 45 (79%) patients, and the outcome measures were inconsistent. For example, activity pain scores were collected from 13 patients, and rest pain scores were collected from 29 patients. Of the 45 patients with outcomes data, 37 (82%) had experienced a numeric or descriptive decrease from initial pain of at least 30%. The reported results were as follows: Mean duration of pain prior to sacroplasty was 3 weeks (IQR 2-5). Procedural complications were minimal. Median post-procedure follow-up time was 2.5 weeks (IQR 1-5) among 45 patients with available data. Thirty-seven (82%) of the 45 patients experienced a numerical or descriptive decrease from initial pain at follow-up. Median activity pain scores collected from 13 patients decreased from 10 (IQR 8.5-10) pre-procedure to 6 (IQR 4-6.8) post-procedure ($p<0.0001$), and median rest pain scores collected from 29 patients decreased from 7 (IQR 4-8.5) to 2 (IQR 1-3.5) ($p<0.0001$). Twenty-two (76%) of 29 patients had at least a 30% decrease in rest pain scores. The median number of opioids prescribed per patient decreased from 1 (IQR 1-2) pre-procedure to 0 (IQR 0-1) post-procedure ($p<0.0001$). Thirty-four of 57 patients (60%) had decreased opioid usage, 15 (26%) patients had unchanged usage and 8 (14%) had increased usage. The author's concluded series demonstrates that sacroplasty is a safe and effective treatment in patients with painful osteoporotic insufficiency fractures.

(2013) Kortman et al. reported on the largest series, a retrospective multicenter analysis. They evaluated 204 patients with painful sacral insufficiency fractures and 39 patients with symptomatic sacral lesions treated with the short-axis or long-axis technique. One hundred sixty-nine patients had bilateral sacral insufficiency fractures, and 65 patients had additional fractures of the axial skeleton. Visual analogue scale scores improved from 9.2 before treatment to 1.9 after treatment in patients with sacral insufficiency fractures and from 9.0 to 2.6 in patients with sacral lesions. There was 1 case of radicular pain due to extravasation of cement requiring surgical decompression. Additionally in the two hundred and forty-three patients were included in the study, 204 with painful sacral insufficiency fractures and 39 with symptomatic sacral lesions. The average pre-

treatment VAS score of 9.2±1.1 was significantly improved after sacroplasty to 1.9±1.7 in patients with sacral insufficiency fractures ($p<0.001$). There were no major complications or procedure-related deaths. One patient who was treated for a sacral insufficiency fracture experienced radicular pain due to local extravasation of cement that subsequently required surgical decompression for symptomatic relief. The authors concluded CT-guided percutaneous sacroplasty is a safe and effective procedure in the treatment of painful sacral insufficiency fractures or lesions. It is associated with prompt and durable pain relief and should be considered as an effective treatment option in this patient population.

Percutaneous Sacroplasty: Adverse Events
There are complications related to cement leakage with sacroplasty that are not observed with vertebroplasty. Leakage of polymethylmethacrylate into the presacral space, spinal canal, sacral foramen, or sacroiliac joint may result in pelvic injection of polymethylmethacrylate, sacral nerve root or sacral spinal canal compromise, or sacroiliac joint dysfunction. Performing sacroplasty only on zone 1 fractures can minimize these risks.

Percutaneous Sacroplasty: Section Summary
No RCTs evaluating percutaneous sacroplasty for sacral insufficiency were identified. The available evidence includes 2 prospective cohort studies and several retrospective series. These studies have reported rapid and sustained decreases in pain following percutaneous sacroplasty. Additional reports are mostly consistent in reporting immediate improvement following the procedure. Due to the limited number of individuals and the retrospective nature of the evidence base, harms associated with sacroplasty have not been adequately studied. The small numbers of treated individuals leave uncertainty regarding the impact of sacroplasty on net health outcomes.

Radiofrequency Kyphoplasty

Clinical Context and Therapy Purpose
The purpose of radiofrequency kyphoplasty is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as conservative care, in individuals with osteoporotic or osteolytic vertebral compression fractures.

The question addressed in this evidence review is: Does the use of radiofrequency kyphoplasty improve the net health outcome for individuals who have osteoporotic vertebral compression fracture or osteolytic vertebral compression fractures?

The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest is individuals with osteoporotic or osteolytic vertebral compression fractures.

Interventions
The therapy being considered is radiofrequency kyphoplasty. The intervention uses radiofrequency energy to ablate metastatic malignant lesions in a vertebral body to provide symptomatic relief.

Comparators
Comparators of interest include conservative care. Treatment includes bed rest, local and systemic analgesia, and bracing, in a home setting as well as an outpatient clinical setting by a primary care provider.

Outcomes
The general outcomes of interest are symptoms, functional outcomes, quality of life, hospitalizations, and treatment-related morbidity.

The existing literature evaluating radiofrequency kyphoplasty as a treatment for osteoporotic or osteolytic vertebral compression fractures has varying lengths of follow-up, ranging from 36 to 80 months. While studies described below all reported at least one outcome of interest, longer follow-up is necessary to fully observe outcomes.

Review of Evidence
(2017) Feng et al. performed a meta-analysis comparing radiofrequency kyphoplasty with balloon kyphoplasty in patients with vertebral compression fractures. Six studies (N=833 patients) evaluating vertebral compression fractures were identified. The main outcomes were pain relief (visual analog scale), functionality improvement (Oswestry Disability Index), operation time, reduction of deformity (i.e., the restoration of vertebral height and kyphosis angle), and incidence of cement leakage. Visual analog score improved for both groups after the respective procedure; however, visual analog scale score dropped 3.96 points more in the radiofrequency kyphoplasty group (95% CI, 1.67 to 6.24; p=0.001), with improvement persisting until the 12-month mark. While functionality improvement was initially improved more after radiofrequency kyphoplasty than balloon kyphoplasty (p=0.04), the difference between the 2 groups was not significant after a year (p=0.6). No significant difference in cement leakage between groups was observed. This review was limited by the small number of studies included as well as the presence of significant bias within these studies.

(2016) Petersen et al. reported on an RCT with 80 patients that compared radiofrequency kyphoplasty with balloon kyphoplasty. Patients had been admitted to the hospital for severe back pain and met criteria for surgery after failed conservative treatment. All had osteoporotic compression fractures. Before treatment, visual analog scale pain scores on movement were similar in both groups (8.4 in the balloon kyphoplasty group vs 8.0 in the radiofrequency kyphoplasty group). Postoperatively, visual analog scores improved by 4.6 after balloon kyphoplasty and 4.4 after radiofrequency kyphoplasty (p=not significant). Pain at 12 months also did not differ significantly between both groups, with 58% of patients in the balloon kyphoplasty group and 66% of patients in the

radiofrequency kyphoplasty group reporting no to mild pain on movement (p=not significant). There was a trend for greater restoration of the kyphosis angle.

Section Summary: Radiofrequency Kyphoplasty
For radiofrequency kyphoplasty, the evidence includes a meta-analysis study and a RCT. While the RCT showed similar results compared with balloon kyphoplasty, an improvement in immediate pain relief after RCT was noted in the meta-analysis. Further high-quality studies are needed to determine with greater certainty whether radiofrequency kyphoplasty has outcomes similar to balloon kyphoplasty.

The major limitation of all these RCTs was the lack of a sham procedure. Due to the possible sham effect observed in the recent trials of vertebroplasty, the validity of results from non-sham-controlled trials is questionable. Therefore, it is not possible to conclude that these improvements are a true treatment effect. Cement leakage, although slightly reduced in kyphoplasty relative to vertebroplasty, remains a concern.

UptoDate
(2020; Literature Review Current though 03/2022) Portenoy et al. on UptoDate reported on vertebral augmentation procedures — Vertebroplasty and kyphoplasty are accepted options for carefully selected patients with symptomatic pathological vertebral fractures without epidural disease or retropulsion of bone fragments into the spinal cord and with pain that is refractory to noninvasive therapies. Vertebroplasty and kyphoplasty are percutaneous injection techniques that may reduce pain and, in some cases, stabilize the fracture. Vertebroplasty involves the percutaneous injection of bone cement (methylmethacrylate) under fluoroscopic guidance into a collapsed vertebral body. Kyphoplasty involves the introduction of inflatable bone tamps into the vertebral body; once inflated, the bone tamps variably restore the height of the vertebral body while creating a cavity that can then be filled with viscous bone cement.

Vertebral augmentation techniques have been used for treatment of painful vertebral collapse in patients with osteoporosis and bone metastases. The evidence in support of vertebroplasty and kyphoplasty for the treatment of painful vertebral collapse in populations with osteoporotic disease is modest and conflicting.

The evidence is also modest and conflicting in patients with malignant vertebral compression fracture. Nonetheless, systematic reviews of studies conducted in cancer populations report improved pain control in more than one-half of patients, and reductions in analgesic use and pain-related disability scores. Although most of the data come from retrospective reports, there is one randomized (although nonblinded) trial of kyphoplasty for treatment in which 134 patients with cancer (37 percent with myeloma) and painful vertebral body compression fractures were randomly assigned to kyphoplasty versus nonsurgical management. Crossover to kyphoplasty was allowed for patients undergoing initial nonsurgical management at one month. In an intention-to-treat analysis, kyphoplasty resulted in decreased back-specific disability at one month and a lower percentage of patients requiring walking aids (46 versus 25 percent), bracing (22

versus 2 percent), bed rest (46 versus 23 percent), and medications of any kind (82 versus 52 percent). All patients who underwent kyphoplasty (whether initially or after crossover from the control group) had sustained improvements over 12 months. There were two adverse events in the kyphoplasty group: one non-Q wave infarction attributed to anesthesia, and adjacent vertebral fracture attributed to the procedure.

Kyphoplasty and vertebroplasty are typically reserved for patients with symptomatic vertebral body fractures without epidural disease or retropulsion of bone fragments into the spinal cord. A vertebral body fracture with a posterior cortical breach is a relative contraindication to kyphoplasty/vertebroplasty. However, at least some data suggest that balloon kyphoplasty is safe and effective in this setting in experienced hands, albeit with a higher risk of cement extravasation. Patients who have involvement of the posterior elements (facet joints or laminae) require an additional posterior tension band. This can be accomplished with the placement of percutaneous pedicle screws at adjacent levels, in addition to cement augmentation at the index level. In the cervical spine, open procedures are still required, although transoral vertebroplasty of the C2 level has been attempted. Gross instability of the cervical and upper thoracic spine requires an open instrumented fusion.

Contraindications – Vertebroplasty/kyphoplasty should be restricted to patients without epidural disease. Other contraindications include the presence of neurologic damage related to fracture, fractures with a burst component (where bone fragments extend into the spinal canal), systemic or local infection, an uncorrected hypercoagulable state, and severe cardiopulmonary disease.

Kyphoplasty versus vertebroplasty – Data comparing kyphoplasty with vertebroplasty in cancer patients are limited. In one small study of 34 patients with symptomatic vertebral compression fractures related to multiple myeloma, patients with >50 percent compression underwent kyphoplasty, whereas patients with <50 percent compression underwent vertebroplasty. Both procedures reduced overall pain and analgesic use, with modestly greater reductions in pain at six months and one year with kyphoplasty. There was no difference in complications.

Given the limitations in the data, the choice between kyphoplasty and vertebroplasty generally is based on clinician preference and expertise, and patient factors. Kyphoplasty is more expensive, but cement extravasation is more common with vertebroplasty. Some practitioners favor kyphoplasty in cases of significant kyphosis (deformity more than 20 degrees) or if there is posterior vertebral cortex involvement, which makes cement extravasation from vertebroplasty more likely. On the other hand, vertebroplasty may be preferred when insertion of the balloon device is technically difficult due to severe vertebral collapse (>65 percent reduction in vertebral height) or if the fracture is more than three months old, in which case elevation of the endplate is unlikely.

This approach differs somewhat from the recommendation of an international myeloma working group, which suggests the use of kyphoplasty rather than vertebroplasty for

patients with painful vertebral compression fractures. However, a pooled analysis of 34 published case series conducted after this guideline was established concluded that both procedures were equally effective in patients with a vertebral compression fracture related to myeloma. This subject is discussed in more detail elsewhere. (See "Multiple myeloma: Treatment of complications", section on 'Kyphoplasty and vertebroplasty'.)

Complications – The risk of adverse outcomes appears to be low when the procedure is performed by an experienced physician. Nevertheless, serious complications have occurred, including pulmonary embolism, spinal cord compression, and paraplegia. Intradural cement leakage requiring spinal surgery is a rare complication.

Alternative therapies — Vertebral fractures may compromise facet structures. For cases in which vertebroplasty/kyphoplasty may not be possible or effective, pain related to the posterior elements may be reduced through medial branch radiofrequency ablation or facet injections. (*Accessed April 2022*)

(2020; Literature Review Current through 05/2022) Rosen et al. on UptoDate reported Patient selection is a critical factor for both the decision to perform vertebral augmentation and for the selection of the type of procedure. Vertebral augmentation is not indicated for patients with mild to moderate pain that is responding to medical management. For patients with incapacitating pain from acute and subacute vertebral compression fractures who are unable to taper parenteral or transition to oral opioids within seven days of admission or have intolerable sedation, constipation, or delirium from this therapy, we suggest vertebral augmentation rather than continued medical management (Grade 2C).

This is typically performed during the initial hospitalization. Vertebral augmentation is also an option for those without improvement in pain despite four to six weeks of conservative management with oral opioids and calcitonin, or for those who are intolerant of oral opioids.

Vertebroplasty and kyphoplasty appear to perform similarly. Kyphoplasty is more technically challenging than vertebroplasty as it involves bilateral placement in nearly all cases and relies on the use of a balloon tamponade system that can have technical difficulties. Vertebroplasty does not commit to a bipedicular approach, does not rely on the performance of a balloon system, and is less expensive. (*Accessed April 2022*)

Summary of Evidence:
For individuals who have symptomatic osteoporotic vertebral fractures between 6 weeks and 1 year old who receive vertebroplasty, the evidence includes 2 randomized sham-controlled trials, nonblinded randomized controlled trials (RCTs) comparing vertebroplasty with conservative management, and several meta-analyses. Relevant outcomes are symptoms, functional outcomes, quality of life, hospitalizations, medication use, and treatment-related morbidity. Despite the completion of multiple RCTs, including with sham controls, the efficacy of vertebroplasty for painful osteoporotic compression

fractures remains uncertain. Two meta-analysis studies that included the 2 sham-controlled trials have demonstrated mixed results. The studies which had methodologic issues, including the choice of sham procedure and the potential of the sham procedure to have a therapeutic effect by reducing pain. Questions have also been raised about the low percentage of patients screened who participated in the trial, the volume of polymethylmethacrylate injected, and the inclusion of patients with chronic pain. Other meta-analyses had numerous limitations due to the heterogeneity of included studies or not specifying the timeframe for osteoporotic vertebral compression fractures. Overall, conclusions about the effect of vertebroplasty remain unclear. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals with symptomatic osteoporotic vertebral fractures less than 6 weeks old who receive vertebroplasty, the evidence includes a randomized sham-controlled trial and nonblinded RCTs comparing vertebroplasty with conservative management. Relevant outcomes are symptoms, functional outcomes, quality of life, hospitalizations, medication use, and treatment-related morbidity. For acute fractures, conservative therapy consisting of rest, analgesics, and physical therapy is an option, and symptoms will resolve in a large percentage of patients with conservative treatment only. However, a sham-controlled randomized trial in patients who had severe pain of fewer than 6 weeks in duration found a significant benefit of vertebroplasty for the treatment of osteoporotic vertebral fracture at the thoracolumbar junction. Other RCTs without sham controls have reported that vertebroplasty is associated with significant improvements in pain and reductions in the duration of bed rest. Given the high morbidity associated with extended bed rest in older adults, this procedure is considered to have a significant health benefit. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

Vertebroplasty has been investigated as an intervention to provide mechanical support and symptomatic relief in patients with osteoporotic vertebral compression fracture or in those with osteolytic lesions of the spine, i.e., multiple myeloma or metastatic malignancies. Clinical input obtained in 2008 provided uniform support for the use of vertebroplasty in painful osteoporotic fractures. After consideration of the available evidence and clinical input, it was concluded that the consistent results of numerous case series, including large prospective reports, together with the results of clinical vetting, were sufficient to determine that vertebroplasty was a reasonable treatment option in patients with vertebral fractures who fail to respond to conservative treatment (at least 6 weeks with analgesics, physical therapy, and rest). It is also clinically reasonable to consider the evidence supporting the clinical benefit of vertebroplasty in osteoporotic vertebral fracture to support its use in osteolytic lesions of the spine (e.g., multiple myeloma, metastatic malignancies).

For individuals with sacral insufficiency fractures who receive sacroplasty, the evidence includes 2 prospective cohort studies and a case series. Relevant outcomes are symptoms, functional outcomes, quality of life, hospitalizations, medication use, and treatment-

related morbidity. No RCTs have been reported. The available evidence includes a prospective cohort study and several retrospective series. These studies have reported rapid and sustained decreases in pain following percutaneous sacroplasty. Additional literature has mostly reported immediate improvements following the procedure. However, due to the small size of the evidence base, the harms associated with sacroplasty have not been adequately studied. This technology has yet to receive FDA approval for use. The spinoplasty procedure has yet to show efficacy and durability on net health outcomes The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have osteoporotic vertebral compression fracture who receive balloon kyphoplasty, or mechanical vertebral augmentation (Kiva), the evidence includes RCTs and meta-analyses. Relevant outcomes include symptoms, functional outcomes, quality of life, hospitalizations, and treatment-related morbidity. A meta-analysis and moderately sized unblinded RCT have compared kyphoplasty with conservative care and found short-term benefits in pain and other outcomes. One systematic review of RCTs found no significant difference in subsequent fracture between vertebroplasty and conservative treatment, and another systematic review of prospective and retrospective studies reported improved mortality with either vertebroplasty or balloon kyphoplasty compared with conservative treatment. Other RCTs, summarized in a meta-analysis, have reported similar outcomes for kyphoplasty and vertebroplasty. Three randomized trials that compared mechanical vertebral augmentation (Kiva or SpineJack) with kyphoplasty have reported similar outcomes for both procedures. A major limitation of all these RCTs is the lack of a sham procedure. Due to the possible sham effect observed in the recent trials of vertebroplasty, the validity of the results from non-sham-controlled trials is unclear. Therefore, whether these improvements represent a true treatment effect is uncertain. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have osteolytic vertebral compression fracture who receive balloon kyphoplasty or mechanical vertebral augmentation, the evidence includes RCTs, case series, and a systematic review of these studies. Relevant outcomes include symptoms, functional outcomes, quality of life, hospitalizations, and treatment-related morbidity. Two RCTs have compared balloon kyphoplasty with conservative management, and another has compared Kiva with balloon kyphoplasty. Results of these trials, along with case series, would suggest a reduction in pain, disability, and analgesic use in patients with cancer-related compression fractures. However, because the results of the comparative studies of vertebroplasty have suggested possible placebo or natural history effects, the evidence these studies provide is insufficient to warrant conclusions about the effect of kyphoplasty on health outcomes.

For individuals who have osteoporotic or osteolytic vertebral compression fracture who receive radiofrequency kyphoplasty, the evidence includes a systematic review and an RCT. Relevant outcomes include symptoms, functional outcomes, quality of life, hospitalizations, and treatment-related morbidity. The only RCT (N =80) identified

showed similar results between radiofrequency kyphoplasty and balloon kyphoplasty. The systematic review suggested that radiofrequency kyphoplasty is superior to balloon kyphoplasty in pain relief, but the review itself was limited by the inclusion of a small number of studies as well as possible bias. Corroboration of these results in a larger number of individuals would be needed to determine with greater certainty whether radiofrequency kyphoplasty provides outcomes similar to balloon kyphoplasty.

After consideration of uniform clinical input, it was concluded that although the scientific evidence does not permit conclusions about the impact on health outcomes and that comparative studies with long-term outcomes are lacking, numerous case series, including large prospective reports, have consistently shown that vertebroplasty or percutaneous balloon kyphoplasty may alleviate pain and improve function in individuals with osteoporotic vertebral fractures who fail to respond to conservative treatment (at least 6 weeks) with analgesics, physical therapy, and rest. More recent randomized trials that have compared percutaneous balloon kyphoplasty with medical management have also reported benefit. Given the absence of alternative treatment options and the morbidity associated with extended bedrest, percutaneous balloon kyphoplasty and mechanical vertebral augmentation may be considered reasonable treatment options in individuals with vertebral fractures who fail to improve after 6 weeks of conservative therapy and therefore may be considered medically necessary both for the individual population whom fail to improve after 6 weeks of conservative therapy and populations with severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have osteoporotic or osteolytic vertebral compression fracture who receive radiofrequency kyphoplasty, the evidence includes a systematic review and an RCT. The relevant outcomes include symptoms, functional outcomes, quality of life, hospitalizations, and treatment-related morbidity. An identified RCT showed similar results between radiofrequency kyphoplasty and balloon kyphoplasty. The systematic review suggested that radiofrequency kyphoplasty is superior to balloon kyphoplasty in pain relief, but the review itself has limitations. It was limited by the inclusion of a small number of studies as well as possible bias. Corroboration of these results in a larger number of individuals would be needed to determine with greater certainty whether radiofrequency kyphoplasty provides outcomes similar to balloon. The evidence is insufficient to determine that the technology results in an improvement in the net health outcomes.

Practice Guidelines and Position Statements

American Academy of Orthopedic Surgeons (AAOS)

(2011) The **American Academy of Orthopedic Surgeons (AAOS)** published a clinical practice guideline and evidence report on the treatment of symptomatic osteoporotic spinal compression fractures recommending:

- We recommend against vertebroplasty for patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically intact.
- Kyphoplasty is an option for patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically intact.
    - They report literature could support a moderate strength recommendation for kyphoplasty due to the two-level II studies, which compared kyphoplasty with conservative treatment. However, the comparisons between vertebroplasty and kyphoplasty are important. The results of the direct comparisons between kyphoplasty and vertebroplasty are not repeated across all studies, which lowers our confidence that future studies will confirm the results of the current evidence. Thus, the recommendation is downgraded from Moderate to Weak, and kyphoplasty is an option for patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically intact.
- We suggest patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms suggesting an acute injury (0-5 days after identifiable event or onset of symptoms) and who are neurologically intact be treated with calcitonin for 4 weeks. (Strength of recommendation: moderate)
- We are unable to recommend for or against any specific treatment of patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are not neurologically intact. (Strength of recommendation: Inconclusive)
- Ibandronate and strontium ranelate are options to prevent additional symptomatic fractures in patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms. (Strength of recommendation: weak)
- We are unable to recommend for or against bed rest, complementary and alternative medicine, or the use of opioids/analgesics for patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically intact. (Strength of recommendation: inconclusive)
- An L2 nerve root block is an option in treating patients who present with an osteoporotic spinal compression fracture at L3 or L4 on imaging with correlating clinical signs and symptoms suggesting an acute injury and who are neurologically intact. (Strength of recommendation: Weak)
- We are unable to recommend for or against treatment with a brace for patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically intact. (Strength of recommendation: Inconclusive)
- We are unable to recommend for or against a supervised or unsupervised exercise program for patients who present with an osteoporotic spinal compression fracture

on imaging with correlating clinical signs and symptoms and who are neurologically intact. (Strength of recommendation: Inconclusive)

- We are unable to recommend for or against electrical stimulation for patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically intact. (Strength of recommendation: Inconclusive)
- We are unable to recommend for or against improvement of kyphosis angle in the treatment of patients who present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms. (Strength of recommendation: Inconclusive)

(*Accessed April 2022*)

American College of Radiology

(2018) The American College of Radiology (ACR) revised its Appropriateness Criteria for the use of percutaneous vertebral augmentation in the management of vertebral compression fractures.· shows the appropriateness categories for each variant.

Variants	Appropriateness Category
"New symptomatic compression fracture identified on radiographs or CT. No known malignancy."	May Be Appropriate
"Osteoporotic compression fracture, with or without edema on MRI and no ‘red flags.' With or without spinal deformity, worsening symptoms, or pulmonary dysfunction."	Usually Appropriate
"Asymptomatic pathologic spinal fracture with or without edema on MRI."	May Be Appropriate
"Pathologic spinal fracture with severe and worsening pain."	Usually Appropriate
"Pathologic spinal fracture with spinal deformity or pulmonary dysfunction."	Usually Appropriate

(*Accessed April 2022*)

American Academy of Orthopaedic Surgeons

(2011) The American Academy of Orthopaedic Surgeons (AAOS) published practice guidelines on the treatment of osteoporotic spinal compression fractures.

- "a Strong recommendation was made against the use of vertebroplasty for patients who present with an acute osteoporotic spinal compression fracture and are neurologically intact." (*Accessed April 2022*)

American Society of Bone and Mineral Research (ASBMR)

(2017) In a review of pain, quality of life and safety outcomes of balloon kyphoplasty compared to other surgical techniques and non-surgical management for vertebral compression fractures (VCF), the ASBMR evaluated ten unique trials (1,837

participants). Balloon kyphoplasty in comparison to non-surgical management, was associated with greater reductions in pain, back-related disability, and better quality of life that appeared to lessen over time but were less than minimally clinically important differences. Risk of new VCF at 3 and 12 months was not significantly different. Individuals with painful VCF experienced symptomatic improvement compared with baseline with all interventions. There were no significant differences between balloon kyphoplasty and percutaneous vertebroplasty in back pain, back disability, quality of life, risk of new VCF or any adverse events. Limitations of the studies included lack of a balloon kyphoplasty versus sham comparison, availability of only one randomized controlled trial of balloon kyphoplasty versus non-surgical management, and lack of study blinding. The authors noted that the clinical importance of the greater improvements with balloon kyphoplasty versus non-surgical management is unclear, may be due to placebo effect, and may not counterbalance short-term adverse event risks. Outcomes appeared similar between balloon kyphoplasty and other surgical interventions.

- The ASMBR recommends well-conducted randomized trials comparing balloon kyphoplasty with sham to help resolve remaining uncertainty about the relative benefits and harms of this procedure. *(Accessed April 2022)*

National Comprehensive Cancer Network (NCCN)

- **Bone Cancer**
    - (Version 2.2022) No recommended guidance for the use of vetebroplasty, kyphoplasty or sacroplasty in individuals with symptomatic spinal fractures related to bone cancer noted. (*Accessed April 2022*)

- **Multiple Myeloma**
    - (Version 5.2022) NCCN noted the following in the Supportive Care for Multiple Myeloma section:
        - Consider vertebroplasty or kyphoplasty for symptomatic vertebral compression fractures. (Accessed April 2022)

National Institute for Health and Care Excellence (NICE)

- (2016) NICE issued guidance which indicated the evidence on percutaneous insertion of craniocaudal expandable implants for vertebral compression fracture raises no major safety concerns. Evidence on its efficacy is adequate. Therefore, this procedure may be used provided those standard arrangements are in place for clinical governance, consent and audit.
    - Patient selection and treatment should be done by a specialist multidisciplinary team that includes a radiologist and a spinal surgeon.
    - The procedure should be limited to patients whose pain is refractory to more conservative treatment.
    - Vertebral compression fractures usually occur when the front of the vertebral body collapses, and may be caused by trauma, cancer or osteoporosis

- Pain is the most common symptom in patients with vertebral compression fractures. Fractures can also cause progressive spinal deformity with abnormal curvature (kyphosis). This can lead to increased risk of further fracture at adjacent levels and progressive malalignment, deformity and pain.
- Treating vertebral compression fractures aims to reduce pain, improve function and minimize the incidence of new fractures. Non-invasive treatment (such as pain medication, bed rest, and back braces) focuses on relieving symptoms and supporting the spine.
- Surgery such as percutaneous vertebroplasty and balloon kyphoplasty may be considered in patients whose condition is refractory to medical therapy and when there is continued vertebral collapse and severe pain. Sometimes more invasive surgery with vertebral body realignment and instrumented fusion (bone grafts and spinal rods) may be needed.

(*Accessed April 2022*)

- (2013) NICE guidance which indicated that percutaneous vertebroplasty and percutaneous balloon kyphoplasty "are recommended as options for treating osteoporotic vertebral compression fractures" in people having
  - "severe, ongoing pain after a recent, unhealed vertebral fracture despite optimal pain management"
  - whose "pain has been confirmed to be at the level of the fracture by physical examination and imaging."

  (Accessed April 2022)
- (2008) NICE issued guidance on the diagnosis and management of adults with metastatic spinal cord compression. This guidance indicated that vertebroplasty or kyphoplasty should be considered for:
  - "Patients who have vertebral metastases and no evidence of metastatic spinal cord compression or spinal instability if they have: mechanical pain resistant to conventional pain management, or vertebral body collapse." *(Accessed April 2022)*
- (2003) NICE concluded in its guidance on percutaneous vertebroplasty:
  - The current evidence on the safety and efficacy of vertebroplasty for vertebral compression fractures appeared "adequate to support the use of this procedure" to "provide pain relief for people with severe painful osteoporosis with loss of height and/or compression fractures of the vertebral body…." The guidance also recommended that the procedure be limited to patients whose pain is refractory to more conservative treatment. (*Accessed April 2022*)

Joint Guidelines

American Association of Clinical Endocrinologists (AACE) and the American College of Endocrinology (ACE)

(2020) In a clinical practice guideline for the diagnosis and treatment of postmenopausal osteoporosis, the AACE and ACE noted the following:

- Vertebroplasty and kyphoplasty are not recommended as first-line treatment of vertebral fractures, given an unclear benefit on overall pain and a potential increased risk of vertebral fractures in adjacent vertebrae (Grade A, BEL 1). *(Accessed April 2022)*

American College of Radiology (ACR), American Society of Neuroradiology (ASNR), Society of Neurointerventional Surgery (SNIS), American Society of Spine Radiology (ASSR), and the Society of Interventional Radiology (SIR)
(2017) The AANS, CNS, ACR, ASNR, ASSR, CIRA and the SNIS issued a joint practice guideline for the performance of vertebral augmentation (including vertebroplasty and kyphoplasty) which states the major indication for vertebroplasty is the treatment of symptomatic osteoporotic vertebral body compression fracture(s) refractory to medical therapy or vertebral bodies weakened due to neoplasia.

- Failure of medical therapy is defined as follows:
    - For a patient rendered nonambulatory due to pain from weakened or fractured vertebral body, pain persisting at a level that prevents ambulation despite 24 hours of analgesic therapy.
    - For a patient with sufficient pain from weakened or fractured vertebral body that physical therapy is intolerable, pain persisting at that level despite 24 hours of analgesic therapy.
    - For any patient with weakened or fractured vertebral body, unacceptable side effects such as excessive sedation, confusion, or constipation due to the analgesic therapy necessary to reduce pain to a tolerable level.
- The guideline includes the following indications for vertebral augmentation:
    - Painful osteoporotic vertebral compression fracture(s) refractory to medical therapy
    - Vertebral bodies weakened by neoplasm
    - Symptomatic vertebral body microfracture (as documented by magnetic resonance imaging [MRI] or nuclear imaging, and/or lytic lesion seen on CT) without obvious loss of vertebral body height.
- Absolute Contraindications
    - Septicemia
    - Active osteomyelitis of the target vertebra
    - Uncorrectable coagulopathy
    - Allergy to bone cement or opacification agent
- Relative Contraindications
    - Radiculopathy in excess of local vertebral pain, caused by a compressive syndrome unrelated to vertebral collapse. Occasionally preoperative vertebroplasty can be performed before a spinal decompressive procedure.
    - Retropulsion of a fracture fragment causing signs and symptoms of neurological compromise
    - Epidural tumor extension with significant encroachment on the spinal canal
    - Ongoing systemic infection
    - Patient improving on medical therapy

- Prophylaxis in osteoporotic patients (unless being performed as part of a research protocol)
- Myelopathy or cauda equina syndrome originating at the fracture level

(Accessed April 2022)

Regulatory Status

Vertebroplasty, kyphoplasty, and sacroplasty are a surgical procedure and, as such, are not subject to U.S. Food and Drug Administration (FDA) approval.

Bone Cement

- Polymethyl methacrylate bone cement was available as a drug product before enactment of the FDA's device regulation and was at first considered what the FDA termed a "transitional device." It was transitioned to a class III device and then to a class II device, which required future 510(k) submissions to meet "special controls" instead of "general controls" to assure safety and effectiveness. Thus, use of polymethylmethacrylate in vertebroplasty represented an off-label use of an FDA-regulated product before the first FDA approvals.

- The FDA also issued a "Public Health Web Notification: Complications related to the use of bone cement in vertebroplasty and kyphoplasty procedures," which is available at www.fda.gov/cdrh/safety/bonecement.html. This notification is intended to inform the public about reports on safety and to encourage hospitals and other user facilities to report adverse events related to bone cement malfunctions either directly to manufacturers or to MedWatch, the FDA's voluntary reporting program.

  Bone cement has received marketing clearance by the FDA through the 510(k) process are seen in the table below. *This table is not intended to be an all-inclusive list.*

Device	Manufacturer	Date Cleared	510(k) No.	Indication
Cortoss® Bone Augmentation Material	Stryker	2009	K080108	Cortoss® is a nonresorbable synthetic material that is a composite resin-based, bis-glycidyl dimethacrylate. The FDA classifies this product as a polymethylmethacrylate bone cement.
KYPHON® HV-R® Bone Cement	Medtronic	2016	K160983	the fixation of pathologic fractures of the vertebral body using vertebroplasty or kyphoplasty procedures.

KyphX® HV-RTM	Medtronic	2004	K033801	process for the treatment of pathologic fractures of the vertebral body due to osteoporosis, cancer, or benign lesions using a balloon kyphoplasty procedure.
Osteopal® V	Heraeus	2010	K050085	Bone cement which is indicated for the treatment of pathological fractures of the vertebral body due to osteoporosis, cancer, or benign lesions using a vertebroplasty or balloon kyphoplasty.
Parallax® Contour® Vertebral Augmentation Device	ArthroCare	2011	K110183	Used to disrupt cancellous bone and create a void in the vertebral body and fill the void during kyphoplasty or vertebral augmentation procedures.
Spine-Fix® Biomimetic Bone Cement	Teknimed S.A	2005	K043593	Used for the fixation of pathological fractures of the vertebral body using vertebroplasty or kyphoplasty procedures. Painful vertebral compression fractures may result from osteoporosis, benign lesions (hemangioma), and malignant lesions (metastatic cancers, myeloma).

Balloon Kyphoplasty Devices

Balloon kyphoplasty requires the use of an inflatable bone tamp. Devices which have been augmentation devices that have received marketing clearance by the FDA through the 510(k) process for balloon kyphoplasty are listed in the table below which is not intended to be an all-inclusive list.

Device	Manufacturer	Date Cleared	510(k) No.	Indication
13G InterV Kyphoplasty Catheter (Micro)	Pan Medical Ltd.	2016	K162453	To repair vertebral compression fractures

11G InterV Kyphoplasty Catheter (Mini-Flex)				
AVAflex Vertebral Balloon System	Carefusion	2015	K151125	To repair vertebral compression fractures
GUARDIAN-SG Inflatable Bone Expander System	BM Korea Co. Ltd.	2015	K143006	To repair vertebral compression fractures
InterV Kyphoplasty Catheter (Balloon Length: 1015 and 20mm) InterV Kyphoplasty Catheter (Mini) (Balloon Length: 10 15 and 20mm)	Pan Medical Ltd.	2015	K150322	To repair vertebral compression fractures
iVAS Elite Inflatable Vertebral Augmentation System (iVAS Elite Balloon Catheter)	Stryker Corporation	2018	K172116	For the reduction of fractures and/or creation of a void in cancellous bone in the spine.
Joline Kyphoplasty System Allevo	Joline GmbH & Co.	2020	K192449	To repair vertebral compression fractures
MEDINAUT Kyphoplasty System	Imedicom Co. Ltd.	2016	K153296	To repair vertebral compression fractures
Modified Winch Kyphoplasty (15 and 20 mm) 11 Gauge Balloon Catheters	G-21 s.r.l.	2017	K172214	To repair vertebral compression fractures
Osseoflex SB Straight Balloon 10g/4ml Osseoflex SB	Osseon LLC	2015	K150607	To repair vertebral compression fractures

Straight Balloon 10g/2ml				
SpineKure Kyphoplasty System	Hanchang Co. Ltd.	2018	K172871	To repair vertebral compression fractures
Stryker iVAS Elite Inflatable Vertebral Augmentation System (Stryker iVAS Elite Balloon Catheter)	Stryker Corporation	2018	K181752	To repair vertebral compression fractures
TRACKER Kyphoplasty System	GS Medical Co., Ltd	2019	K192335	Reduction of fractures or creation of a void
ZVPLASTY	Zavation LLC	2014	K141419	To repair vertebral compression fractures

Mechanical Vertebral Augmentation Devices
There are several mechanical vertebral augmentation devices that have received marketing clearance by the FDA through the 510(k) process; these are listed in the table below which is not intended to be an all-inclusive list.

Device	Manufacturer	Date Cleared	510(k) No.	Indication
Kiva VCF Treatment System	Benvenue Medical Inc.	2014	K141141	To repair vertebral compression fractures
SpineJack Expansion Kit	Vexim SA	2018	K181262	To repair vertebral compression fractures
V-Strut Vertebral Implant	Hyprevention SAS	2020	K191709	Treatment of vertebral fractures in the thoracic and lumbar spine

Radiofrequency Vertebral Augmentation
StabiliT® Vertebral Augmentation System (Merit Medical) for radiofrequency vertebral augmentation was cleared for marketing in 2009

Sacroplasty

- The use of polymethylmethacrylate in sacroplasty is an off-label use of an FDA-regulated product (bone cements such as Spine-Fix® Biomimetic Bone Cement [Teknimed] and Osteopal® V [Heraeus]) because the 510(k) approval was for the

fixation of pathologic fractures of the vertebral body using vertebroplasty procedures. Sacroplasty was not included.

Please note the above information is not intended to be all inclusive.

PRIOR APPROVAL

Not applicable.

POLICY

Vertebral Augmentation (Percutaneous Vertebroplasty, Percutaneous, Balloon Kyphoplasty or Mechanical Vertebral Augmentation): **Medically Necessary**
Vertebral augmentation (percutaneous vertebroplasty, kyphoplasty or mechanical vertebral augmentation) using an FDA cleared device may be considered **medically necessary** for the treatment of **one of the following**:

- osteolytic or osteoporotic compression fractures which may or may not be caused by trauma; **or**
- osteolytic metastases, including destruction of a vertebral body by multiple myeloma; **or**
- primary malignant neoplasm of bone or bone marrow; **or**
- painful and/or aggressive space-occupying lesions of a vertebral body (e.g., hemangioma/eosinophilic granuloma) **or**
- painful osteonecrotic (e.g., Kummel disease) vertebral compression fracture; **or**
- steroid-induced vertebral compression fracture

and the individual has persistent, debilitating pain related to the fracture or lesion supported by **all of the following**:

- Significant level of pain on a daily basis, defined as **one of the following**:
  - Pain rating scale (e.g., visual analog scale (VAS)/number rating scale (NRS)) greater than or equal to seven; **or**
  - Severe, disabling, crippling, or incapacitating pain;

and the following:

- Clinically significant functional impairment such as limiting performance of instrumental activities of daily living (ADLs). (*Instrumental ADLs are defined as feeding, bathing, dressing, grooming, meal preparation, household chores, and occupational tasks that are required as a daily part of job functioning*).

and the individual has **one of the following**:

- acute (0-6 weeks) axial back pain that persists at a level preventing independent transfers and/or ambulation and correlates with the level of the fracture; **or**
- subacute (> 6 weeks) axial pain in the thoracic/lumbar spine without clinically meaningful improvement with **all of the following**, *unless contraindicated*:
  - prescription-strength analgesics, steroids, and/or NSAIDs for ≥ six weeks; **and**

- provider-directed exercise program prescribed by a physical therapist, chiropractic provider, osteopathic or allopathic physician for ≥ six weeks;

and all of the following:

- Other causes of pain such as herniated intervertebral disk have been ruled out by computed tomography (CT) or magnetic resonance imaging (MRI)
- The procedure is performed at no more than two levels spine on the same date of service.
- The affected vertebra has not been extensively destroyed and is at least 1/3 of its original height.

Vertebral Augmentation (Percutaneous Vertebroplasty, Percutaneous, Balloon Kyphoplasty or Mechanical Vertebral Augmentation): Not Medically Necessary
Vertebral augmentation (percutaneous vertebroplasty, kyphoplasty or mechanical vertebral augmentation) is considered **not medically necessary** when the above criteria has not been met.

Vertebral Augmentation (Percutaneous Vertebroplasty, Percutaneous, Balloon Kyphoplasty or Mechanical Vertebral Augmentation): Investigational
Vertebral augmentation (percutaneous vertebroplasty, kyphoplasty or mechanical vertebral augmentation) is considered **investigational** for all other indications to include but not limited to the following due to a lack of evidence demonstrating an impact on improved health outcomes:

- non-painful/non-aggressive vertebral hemangioma;
- vertebrae of the cervical spine and thoracic levels T1-T4
- stabilization of insufficiency fractures or lesions of the sacrum (sacroplasty) coccyx (coccygeoplasty)
- prophylactic treatment for osteoporosis of the spine
- prophylactic treatment for chronic back pain of long-standing duration (greater than six months), even if associated with old compression fracture(s)

Radiofrequency-Assisted Vertebral Augmentation/Radiofrequency Kyphoplasty
Radiofrequency-assisted vertebral augmentation/Radiofrequency kyphoplasty is considered **investigational** for all indications due to a lack of evidence demonstrating an impact on improved health outcomes.

Percutaneous Sacroplasty
Percutaneous sacroplasty is considered **investigational** for all indications, including but not limited to the following due to a lack of evidence demonstrating an impact on improved health outcomes

- Sacral insufficiency fractures due to osteoporosis
- Sacral lesions due to metastatic malignancies
- Sacral lesions due to multiple myeloma

Spinoplasty
Spinoplasty (e.g., OptiMesh® 1500E Polyethylene Terephthalate (PET) mesh pouch) as a treatment of fracture repair is considered **investigational** due to a lack of evidence demonstrating an impact on improved health outcomes.

Policy Guidelines

Required Documentation
The individual's medical records submitted for review should document the above medical necessity and should include information such as the following, when applicable:

- Onset of the condition, length, and duration
- Documentation of the individual's symptoms, pain, location, and severity including functional impairment interfering with activities of daily living (e.g., meals, walking, getting dressed, driving)
- History and co-morbid medical condition(s)
- No evidence of spinal cord compression
- Treatments tried and failed to include the length of time the treatment was trialed
- Completed report(s) of diagnostic imaging

PROCEDURE CODES AND BILLING GUIDELINES

To report provider services, use appropriate CPT* codes, Alpha Numeric (HCPCS level 2) codes, Revenue codes, and/or ICD diagnosis codes.

- 22510 Percutaneous vertebroplasty (bone biopsy included when performed), 1 vertebral body, unilateral or bilateral injection, inclusive of all imaging guidance; cervicothoracic
- 22511 Percutaneous vertebroplasty (bone biopsy included when performed), 1 vertebral body, unilateral or bilateral injection, inclusive of all imaging guidance; lumbosacral
- 22512 Percutaneous vertebroplasty (bone biopsy included when performed), 1 vertebral body, unilateral or bilateral injection, inclusive of all imaging guidance; each additional cervicothoracic or lumbosacral vertebral body (List separately in addition to code for primary procedure)
- 22513 Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (eg, kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging guidance; thoracic
- 22514 Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (eg, kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging guidance; lumbar

- 22515 Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (eg, kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging guidance; each additional thoracic or lumbar vertebral body (List separately in addition to code for primary procedure)
- 22899 Unlisted procedure, spine (e.g., *may be utilized for spinoplasty*)
- 0200T Percutaneous sacral augmentation (sacroplasty), unilateral injection(s), including the use of a balloon or mechanical device, when used, 1 or more needles, includes imaging guidance and bone biopsy, when performed
- 0201T Percutaneous sacral augmentation (sacroplasty), bilateral injections, including the use of a balloon or mechanical device, when used, 2 or more needles, includes imaging guidance and bone biopsy, when performed
- C1062 Intravertebral body fracture augmentation with implant (e.g., metal, polymer)
- C7504 Percutaneous vertebroplasties (bone biopsies included when performed), first cervicothoracic and any additional cervicothoracic or lumbosacral vertebral bodies, unilateral or bilateral injection, inclusive of all imaging guidance
- C7505 Percutaneous vertebroplasties (bone biopsies included when performed), first lumbosacral and any additional cervicothoracic or lumbosacral vertebral bodies, unilateral or bilateral injection, inclusive of all imaging guidance
- C7507 Percutaneous vertebral augmentations, first thoracic and any additional thoracic or lumbar vertebral bodies, including cavity creations (fracture reductions and bone biopsies included when performed) using mechanical device (eg, kyphoplasty), unilateral or bilateral cannulations, inclusive of all imaging guidance
- C7508 Percutaneous vertebral augmentations, first lumbar and any additional thoracic or lumbar vertebral bodies, including cavity creations (fracture reductions and bone biopsies included when performed) using mechanical device (eg, kyphoplasty), unilateral or bilateral cannulations, inclusive of all imaging guidance

SELECTED REFERENCES

- Wang LJ, Yang HL, Shi YX, et al. Pulmonary cement embolism associated with percutaneous vertebroplasty or kyphoplasty: a systematic review. Orthop Surg. Aug 2012;4(3):182-189. PMID 22927153
- ACR-ASNR-ASSR=SIR-SNIS. Practice guideline for the performance of vertebral augmentation 2012; http://www.acr.org/~/media/ACR/Documents/PGTS/guidelines/Vertebral_Augmentation.pdf.
- Barr JD, Jensen ME, Hirsch JA, et al. Position statement on percutaneous vertebral augmentation: a consensus statement developed by the Society of Interventional Radiology (SIR), American Association of Neurological Surgeons (AANS) and the Congress of Neurological Surgeons (CNS), American College of Radiology (ACR), American Society of Neuroradiology (ASNR), American Society of Spine

Radiology (ASSR), Canadian Interventional Radiology Association (CIRA), and the Society of NeuroInterventional Surgery (SNIS). J Vasc Interv Radiol. Feb 2017
- American College of Radiology. Management of Compression Fractures. 2013; http://www.acr.org/Search?q=Kyphoplasty.
- American Academy of Orthopaedic Surgeons (AAOS). Clinical Practice Guideline Treatment of osteoporotic spinal compression fractures. 2010; http://www.aaos.org/news/aaosnow/oct10/cover1.asp.
- National Institute for Health and Care Excellence (NICE). IPG 12: Percutaneous Vertebroplasty. 2003; http://publications.nice.org.uk/percutaneous-vertebroplasty-ipg12.
- National Institute for Health and Care Excellence (NICE). TA 279 Percutaneous vertebroplasty and percutaneous balloon kyphoplasty for treating osteoporotic vertebral compression fractures. 2013; http://publications.nice.org.uk/percutaneous-vertebroplasty-and-percutaneous-balloon-kyphoplasty-for-treating-osteoporotic-vertebral-ta279.
- ECRI Institute, Health Technology Assessment, StabiliT vertebral augmentation system (Dfine, Inc.) for treating vertebral fractures. June 2016, www.ecri.com
- ECRI Institute, Health Technology Assessment, Overview of four selected balloon kyphoplasty and vertebral augmentation systems. November 2015, www.ecri.com
- Rodriguez AJ, Fink HA, Mirigian L, et al. Pain, quality of life and safety outcomes of kyphoplasty for vertebral compression fractures: report of a task force of the American Society for Bone and Mineral Research. J Bone Miner Res. 2017 May 17. [Epub ahead of print
- Tsoumakidou G, Too CW, Koch G, et al. CIRSE Guidelines on Percutaneous Vertebral Augmentation. Cardiovasc Intervent Radiol 2017;40:331–42
- Chandra RV, Meyers PM, Hirsch JA, et al; Society of NeuroInterventional Surgery. Vertebral Augmentation: report of the Standards and Guidelines Committee of the Society of NeuroInterventional Surgery. J Neurointerv Surg 2014;6:7–15
- Beall D, Coe J, McIlduff M, et al. Serious adverse events associated with readmission through one year after vertebral augmentation with either a polyetheretherketone implant or balloon kyphoplasty. Follow-up analysis of the KAST randomized controlled trial comparing the Kiva Vertebral Compression Fracture Treatment System. Pain Physician. 2017;20:521-528.
- UpToDate, Inc. Evaluation and management of complete and impending pathologic fractures in patients with metastatic bone disease, multiple myeloma and lymphoma. http://www.uptodate.com. Updated June 2018.
- ECRI Institute. Kyphon Balloon Kyphoplasty (Medtronic, plc) for Treating Vertebral Fractures. Plymouth Meeting (PA): ECRI Institute; 2019 Oct 10. (Custom Product Brief).
- ECRI Institute. SpineJack Implantable Fracture Reduction System (Vexim SA) for Treating Vertebral Compression Fractures. Plymouth Meeting (PA): ECRI Institute; 2019 May 01. (Custom Product Brief).
- Treatment for Acute Pain: An Evidence Map Technical Brief Number 33 AHRQ Publication No. 19(20)-EHC022-EF October 2019

- Regulatory Status FDA granted 510(k) marketing clearance for the SpineJack system in August 2018 under the trade name SpineJack Expansion Kit (K181262). The primary predicate device is listed as the Kiva VCF (vertebral compression fracture) Treatment System (K132817), for which FDA granted 510(k) marketing clearance in January 2014.
- ECRI Institute. StabiliT Vertebral Augmentation System (Merit Medical, Inc.) for Treating Vertebral Fractures. Plymouth Meeting (PA): ECRI Institute; 2020 Jan 16. (Custom Product Brief).
- Sorensen ST, Kirkegaard AO, Carreon L, et al. Vertebroplasty or kyphoplasty as palliative treatment for cancer-related vertebral compression fractures: a systematic review. Spine J. 2019 Jun;19(6):1067-1075.
- Liu Q, Cao J, Kong JJ. Clinical effect of balloon kyphoplasty in elderly patients with multiple osteoporotic vertebral fractures. Niger J Clin Pract. 2019 Mar;22(3):289-292.
- Noriega DC, Rodríguez-Monsalve F, Ramajo R, et al. Long-term safety and clinical performance of kyphoplasty and SpineJack® procedures in the treatment of osteoporotic vertebral compression fractures: a pilot, monocentric, investigator-initiated study. Osteoporos Int. 2019 Mar;30(3):637-645.
- Chang, J., Bei, M., Shu, D. et al. Comparison of the clinical outcomes of percutaneous vertebroplasty vs. kyphoplasty for the treatment of osteoporotic Kümmell's disease:a prospective cohort study. BMC Musculoskelet Disord 21, 238 (2020). https://doi.org/10.1186/s12891-020-03271-9
- ECRI Institute. StabiliT Vertebral Augmentation System (Merit Medical, Inc.) for Treating Vertebral Fractures. Plymouth Meeting (PA): ECRI Institute; 2020 Jan 16. (Custom Product Brief).
- ECRI. SpineJack Implantable Fracture Reduction System (Vexim SA) for Treating Vertebral Compression Fractures. Plymouth Meeting (PA): ECRI; 2020 Oct 12. (Clinical Evidence Assessment).
- Gotis-Graham I, McGuigan L, Diamond T, et al. Sacral insufficiency fractures in the elderly. J Bone Joint Surg Br. Nov 1994; 76(6): 882-6. PMID 7983111
- Lin J, Lachmann E, Nagler W. Sacral insufficiency fractures: a report of two cases and a review of the literature. J Womens Health Gend Based Med. Sep 2001; 10(7): 699-705. PMID 11571100
- Bae H, Hatten HP, Linovitz R, et al. A prospective randomized FDA-IDE trial comparing Cortoss with PMMA for vertebroplasty: a comparative effectiveness research study with 24-month follow-up. Spine (Phila Pa 1976). Apr 01 2012; 37(7): 544-50. PMID 21738093
- Dehdashti AR, Martin JB, Jean B, et al. PMMA cementoplasty in symptomatic metastatic lesions of the S1 vertebral body. Cardiovasc Intervent Radiol. May-Jun 2000; 23(3): 235-7. PMID 10821903
- Marcy PY, Palussiere J, Descamps B, et al. Percutaneous cementoplasty for pelvic bone metastasis. Support Care Cancer. Nov 2000; 8(6): 500-3. PMID 11094996
- Aretxabala I, Fraiz E, Perez-Ruiz F, et al. Sacral insufficiency fractures. High association with pubic rami fractures. Clin Rheumatol. 2000; 19(5): 399-401. PMID 11055834

- Leroux JL, Denat B, Thomas E, et al. Sacral insufficiency fractures presenting as acute low-back pain. Biomechanical aspects. Spine (Phila Pa 1976). Dec 1993; 18(16): 2502-6. PMID 8303454
- Newhouse KE, el-Khoury GY, Buckwalter JA. Occult sacral fractures in osteopenic patients. J Bone Joint Surg Am. Dec 1992; 74(10): 1472-7. PMID 1364816
- Stratford PW, Binkley J, Solomon P, et al. Defining the minimum level of detectable change for the Roland-Morris questionnaire. Phys Ther. Apr 1996; 76(4): 359-65; discussion 366-8. PMID 8606899
- Katz J, Melzack R. Measurement of pain. Surg Clin North Am. Apr 1999; 79(2): 231-52. PMID 10352653
- Barr JD, Jensen ME, Hirsch JA, et al. Position statement on percutaneous vertebral augmentation: a consensus statement developed by the Society of Interventional Radiology (SIR), American Association of Neurological Surgeons (AANS) and the Congress of Neurological Surgeons (CNS), American College of Radiology (ACR), American Society of Neuroradiology (ASNR), American Society of Spine Radiology (ASSR), Canadian Interventional Radiology Association (CIRA), and the Society of NeuroInterventional Surgery (SNIS). J Vasc Interv Radiol. Feb 2014; 25(2): 171-81. PMID 24325929
- Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty for vertebral fractures caused by osteoporosis or malignancy. TEC Assessments. 2005;Volume 20:Tab 6.
- Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty for vertebral fractures caused by osteoporosis, malignancy, or hemangioma. TEC Assessments. 2004;Volume 19:Tab 13.
- Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty for vertebral fractures caused by osteoporosis. TEC Assessments. 2010;Volume 25:Tab 9.
- Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis or malignancy. TEC Assessments. 2008;Volume 23:Tab 5.
- Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis. TEC Assessments. 2009;Volume 24:Tab 7.
- Buchbinder R, Johnston RV, Rischin KJ, et al. Percutaneous vertebroplasty for osteoporotic vertebral compression fracture. Cochrane Database Syst Rev. Apr 04 2018; 4: CD006349. PMID 29618171
- Staples MP, Kallmes DF, Comstock BA, et al. Effectiveness of vertebroplasty using individual patient data from two randomised placebo controlled trials: meta-analysis. BMJ. Jul 12 2011; 343: d3952. PMID 21750078
- Xie L, Zhao ZG, Zhang SJ, et al. Percutaneous vertebroplasty versus conservative treatment for osteoporotic vertebral compression fractures: An updated meta-analysis of prospective randomized controlled trials. Int J Surg. Nov 2017; 47: 25-32. PMID 28939236

- Hinde K, Maingard J, Hirsch JA, et al. Mortality Outcomes of Vertebral Augmentation (Vertebroplasty and/or Balloon Kyphoplasty) for Osteoporotic Vertebral Compression Fractures: A Systematic Review and Meta-Analysis. Radiology. Apr 2020; 295(1): 96-103. PMID 32068503
- Zhang L, Zhai P. A Comparison of Percutaneous Vertebroplasty Versus Conservative Treatment in Terms of Treatment Effect for Osteoporotic Vertebral Compression Fractures: A Meta-Analysis. Surg Innov. Feb 2020; 27(1): 19-25. PMID 31423902
- Chang M, Zhang C, Shi J, et al. Comparison Between 7 Osteoporotic Vertebral Compression Fractures Treatments: Systematic Review and Network Meta-analysis. World Neurosurg. Jan 2021; 145: 462-470.e1. PMID 32891841
- Buchbinder R, Osborne RH, Ebeling PR, et al. A randomized trial of vertebroplasty for painful osteoporotic vertebral fractures. N Engl J Med. Aug 06 2009; 361(6): 557-68. PMID 19657121
- Kallmes DF, Comstock BA, Heagerty PJ, et al. A randomized trial of vertebroplasty for osteoporotic spinal fractures. N Engl J Med. Aug 06 2009; 361(6): 569-79. PMID 19657122
- Kroon F, Staples M, Ebeling PR, et al. Two-year results of a randomized placebo-controlled trial of vertebroplasty for acute osteoporotic vertebral fractures. J Bone Miner Res. Jun 2014; 29(6): 1346-55. PMID 24967454
- Ostelo RW, Deyo RA, Stratford P, et al. Interpreting change scores for pain and functional status in low back pain: towards international consensus regarding minimal important change. Spine (Phila Pa 1976). Jan 01 2008; 33(1): 90-4. PMID 18165753
- Comstock BA, Sitlani CM, Jarvik JG, et al. Investigational vertebroplasty safety and efficacy trial (INVEST): patient-reported outcomes through 1 year. Radiology. Oct 2013; 269(1): 224-31. PMID 23696683
- Firanescu CE, de Vries J, Lodder P, et al. Vertebroplasty versus sham procedure for painful acute osteoporotic vertebral compression fractures (VERTOS IV): randomised sham controlled clinical trial. BMJ. May 09 2018; 361: k1551. PMID 29743284
- Chen D, An ZQ, Song S, et al. Percutaneous vertebroplasty compared with conservative treatment in patients with chronic painful osteoporotic spinal fractures. J Clin Neurosci. Mar 2014; 21(3): 473-7. PMID 24315046
- Farrokhi MR, Alibai E, Maghami Z. Randomized controlled trial of percutaneous vertebroplasty versus optimal medical management for the relief of pain and disability in acute osteoporotic vertebral compression fractures. J Neurosurg Spine. May 2011; 14(5): 561-9. PMID 21375382
- Edidin AA, Ong KL, Lau E, et al. Mortality risk for operated and nonoperated vertebral fracture patients in the medicare population. J Bone Miner Res. Jul 2011; 26(7): 1617-26. PMID 21308780
- Edidin AA, Ong KL, Lau E, et al. Morbidity and Mortality After Vertebral Fractures: Comparison of Vertebral Augmentation and Nonoperative Management in the Medicare Population. Spine (Phila Pa 1976). Aug 01 2015; 40(15): 1228-41. PMID 26020845

- Lin JH, Chien LN, Tsai WL, et al. Early vertebroplasty associated with a lower risk of mortality and respiratory failure in aged patients with painful vertebral compression fractures: a population-based cohort study in Taiwan. Spine J. Sep 2017; 17(9): 1310-1318. PMID 28483705
- Clark W, Bird P, Gonski P, et al. Safety and efficacy of vertebroplasty for acute painful osteoporotic fractures (VAPOUR): a multicentre, randomised, double-blind, placebo-controlled trial. Lancet. Oct 01 2016; 388(10052): 1408-1416. PMID 27544377
- Klazen CA, Lohle PN, de Vries J, et al. Vertebroplasty versus conservative treatment in acute osteoporotic vertebral compression fractures (Vertos II): an open-label randomised trial. Lancet. Sep 25 2010; 376(9746): 1085-92. PMID 20701962
- Yi X, Lu H, Tian F, et al. Recompression in new levels after percutaneous vertebroplasty and kyphoplasty compared with conservative treatment. Arch Orthop Trauma Surg. Jan 2014; 134(1): 21-30. PMID 24287674
- Leali PT, Solla F, Maestretti G, et al. Safety and efficacy of vertebroplasty in the treatment of osteoporotic vertebral compression fractures: a prospective multicenter international randomized controlled study. Clin Cases Miner Bone Metab. Sep-Dec 2016; 13(3): 234-236. PMID 28228788
- Yang EZ, Xu JG, Huang GZ, et al. Percutaneous Vertebroplasty Versus Conservative Treatment in Aged Patients With Acute Osteoporotic Vertebral Compression Fractures: A Prospective Randomized Controlled Clinical Study. Spine (Phila Pa 1976). Apr 2016; 41(8): 653-60. PMID 26630417
- Lourie H. Spontaneous osteoporotic fracture of the sacrum. An unrecognized syndrome of the elderly. JAMA. Aug 13 1982; 248(6): 715-7. PMID 7097924
- Frey ME, Depalma MJ, Cifu DX, et al. Percutaneous sacroplasty for osteoporotic sacral insufficiency fractures: a prospective, multicenter, observational pilot study. Spine J. Mar-Apr 2008; 8(2): 367-73. PMID 17981097
- Kortman K, Ortiz O, Miller T, et al. Multicenter study to assess the efficacy and safety of sacroplasty in patients with osteoporotic sacral insufficiency fractures or pathologic sacral lesions. J Neurointerv Surg. Sep 01 2013; 5(5): 461-6. PMID 22684691
- Frey ME, Warner C, Thomas SM, et al. Sacroplasty: A Ten-Year Analysis of Prospective Patients Treated with Percutaneous Sacroplasty: Literature Review and Technical Considerations. Pain Physician. Nov 2017; 20(7): E1063-E1072. PMID 29149151
- Dougherty RW, McDonald JS, Cho YW, et al. Percutaneous sacroplasty using CT guidance for pain palliation in sacral insufficiency fractures. J Neurointerv Surg. Jan 2014; 6(1): 57-60. PMID 23345629
- Zaman FM, Frey M, Slipman CW. Sacral stress fractures. Curr Sports Med Rep. Feb 2006; 5(1): 37-43. PMID 16483515
- Denis F, Davis S, Comfort T. Sacral fractures: an important problem. Retrospective analysis of 236 cases. Clin Orthop Relat Res. Feb 1988; 227: 67-81. PMID 3338224

- Shah LM, Jennings JW, Kirsch CFE, et al. ACR Appropriateness Criteria (R) Management of Vertebral Compression Fractures. J Am Coll Radiol. Nov 2018; 15(11S): S347-S364. PMID 30392604
- Baerlocher MO, Saad WE, Dariushnia S, et al. Quality improvement guidelines for percutaneous vertebroplasty. J Vasc Interv Radiol. Feb 2014; 25(2): 165-70. PMID 24238815
- McGuire R. AAOS Clinical Practice Guideline: the Treatment of Symptomatic Osteoporotic Spinal Compression Fractures. J Am Acad Orthop Surg. Mar 2011; 19(3): 183-4. PMID 21368100
- National Institute for Health and Care Excellence (NICE). Percutaneous vertebroplasty [IPG12]. 2003; https://www.nice.org.uk/guidance/ipg12. Accessed February 24, 2021.
- National Institute for Health and Care Excellence (NICE). Percutaneous vertebroplasty and percutaneous balloon kyphoplasty for treating osteoporotic vertebral compression fractures [TA279]. 2013; https://www.nice.org.uk/guidance/ta279. Accessed February 24, 2021.
- National Institute for Health and Care Excellence (NICE). Metastatic spinal cord compression in adults: risk assessment, diagnosis and management [CG75]. 2008; https://www.nice.org.uk/guidance/cg75/chapter/1- guidance. Accessed February 24, 2021.
- National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Multiple Myeloma. Version 5.2021.
- National Institute for Health and Care Excellence (NICE). Percutaneous insertion of craniocaudal expandable implants for vertebral compression fracture. November 23 2016; https://www.nice.org.uk/guidance/ipg568/resources/percutaneous-insertion-of-craniocaudal-expandable-implants-for-vertebral-compression-fracture-pdf-1899872054443717.
- Rosen HN., Walega DR, Rosen CJ., et al. Osteoporotic thoracolumbar vertebral compression fractures: Clinical manifestations and treatment. Literature review current through: Mar 2022. | This topic last updated: Jun 02, 2020. UptoDate. https://www.uptodate.com/contents/osteoporotic-thoracolumbar-vertebral-compression-fractures-clinical-manifestations-and-treatment?search=percutaneous%20vertebral%20augmentation&source=search_result&selectedTitle=1~23&usage_type=default&display_rank=1#H974428
- Portenoy RK., Copenhaver DJ., Abrahm J., et al. Cancer pain management: Interventional therapies. Literature review current through: Mar 2022. | This topic last updated: May 19, 2020. UptoDate. https://www.uptodate.com/contents/cancer-pain-management-interventional-therapies?search=percutaneous%20vertebral%20augmentation&source=search_result&selectedTitle=2~23&usage_type=default&display_rank=2
- Yu MH., Hoffe SE., Drews RE., et al Overview of therapeutic approaches for adult patients with bone metastasis from solid tumors. Literature review current through: Mar 2022. | This topic last updated: Aug 27, 2021. https://www.uptodate.com/contents/overview-of-therapeutic-approaches-for-adult-patients-with-bone-metastasis-from-solid-

tumors?search=percutaneous%20vertebral%20augmentation&source=search_result&selectedTitle=3~23&usage_type=default&display_rank=3#H2792775982

- Camacho, Pauline M et al. "AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS/AMERICAN COLLEGE OF ENDOCRINOLOGY CLINICAL PRACTICE GUIDELINES FOR THE DIAGNOSIS AND TREATMENT OF POSTMENOPAUSAL OSTEOPOROSIS-2020 UPDATE." Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists vol. 26,Suppl 1 (2020): 1-46. doi:10.4158/GL-2020-0524SUPPL
- Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous Vertebroplasty. TEC Assessments. 2000;Volume 15:Tab 21.
- Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous kyphoplasty for vertebral fractures caused by osteoporosis and malignancy. TEC Assessments. 2004;Volume 19:Tab 12.
- Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous kyphoplasty for vertebral fractures caused by osteoporosis or malignancy. TEC Assessments. 2005;Volume 20:Tab 7.
- Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis or malignancy. TEC Assessments. 2008;Volume 23:Tab 5.
- Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis. TEC Assessments. 2009;Volume 24:Tab 7.
- Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis. TEC Assessments. 2010;Volume 25:Tab 9.
- Jarvik JG, Deyo RA. Cementing the evidence: time for a randomized trial of vertebroplasty. AJNR Am J Neuroradiol. Sep 2000; 21(8): 1373-4. PMID 11003266
- Moerman DE, Jonas WB. Deconstructing the placebo effect and finding the meaning response. Ann Intern Med. Mar 19 2002; 136(6): 471-6. PMID 11900500
- Hrobjartsson A, Gotzsche PC. Is the placebo powerless? An analysis of clinical trials comparing placebo with no treatment. N Engl J Med. May 24 2001; 344(21): 1594-602. PMID 11372012
- Vase L, Riley JL, Price DD. A comparison of placebo effects in clinical analgesic trials versus studies of placebo analgesia. Pain. Oct 2002; 99(3): 443-452. PMID 12406519
- Buchbinder R, Osborne RH, Ebeling PR, et al. A randomized trial of vertebroplasty for painful osteoporotic vertebral fractures. N Engl J Med. Aug 06 2009; 361(6): 557-68. PMID 19657121
- Zhao S, Xu CY, Zhu AR, et al. Comparison of the efficacy and safety of 3 treatments for patients with osteoporotic vertebral compression fractures: A network meta-analysis. Medicine (Baltimore). Jun 2017; 96(26): e7328. PMID 28658144

- Hinde K, Maingard J, Hirsch JA, et al. Mortality Outcomes of Vertebral Augmentation (Vertebroplasty and/or Balloon Kyphoplasty) for Osteoporotic Vertebral Compression Fractures: A Systematic Review and Meta-Analysis. Radiology. Apr 2020; 295(1): 96-103. PMID 32068503
- Sun HB, Jing XS, Tang H, et al. Clinical and radiological subsequent fractures after vertebral augmentation for treating osteoporotic vertebral compression fractures: a meta-analysis. Eur Spine J. Oct 2020; 29(10): 2576-2590. PMID 32776263
- Edidin AA, Ong KL, Lau E, et al. Mortality risk for operated and nonoperated vertebral fracture patients in the medicare population. J Bone Miner Res. Jul 2011; 26(7): 1617-26. PMID 21308780
- Ong KL, Beall DP, Frohbergh M, et al. Were VCF patients at higher risk of mortality following the 2009 publication of the vertebroplasty sham trials?. Osteoporos Int. Feb 2018; 29(2): 375-383. PMID 29063215
- Wardlaw D, Cummings SR, Van Meirhaeghe J, et al. Efficacy and safety of balloon kyphoplasty compared with non-surgical care for vertebral compression fracture (FREE): a randomised controlled trial. Lancet. Mar 21 2009; 373(9668): 1016-24. PMID 19246088
- Boonen S, Van Meirhaeghe J, Bastian L, et al. Balloon kyphoplasty for the treatment of acute vertebral compression fractures: 2-year results from a randomized trial. J Bone Miner Res. Jul 2011; 26(7): 1627-37. PMID 21337428
- Van Meirhaeghe J, Bastian L, Boonen S, et al. A randomized trial of balloon kyphoplasty and nonsurgical management for treating acute vertebral compression fractures: vertebral body kyphosis correction and surgical parameters. Spine (Phila Pa 1976). May 20 2013; 38(12): 971-83. PMID 23446769
- Tutton SM, Pflugmacher R, Davidian M, et al. KAST Study: The Kiva System As a Vertebral Augmentation Treatment-A Safety and Effectiveness Trial: A Randomized, Noninferiority Trial Comparing the Kiva System With Balloon Kyphoplasty in Treatment of Osteoporotic Vertebral Compression Fractures. Spine (Phila Pa 1976). Jun 15 2015; 40(12): 865-75. PMID 25822543
- Korovessis P, Vardakastanis K, Repantis T, et al. Balloon kyphoplasty versus KIVA vertebral augmentation--comparison of 2 techniques for osteoporotic vertebral body fractures: a prospective randomized study. Spine (Phila Pa 1976). Feb 15 2013; 38(4): 292-9. PMID 23407406
- Noriega D, Marcia S, Theumann N, et al. A prospective, international, randomized, noninferiority study comparing an implantable titanium vertebral augmentation device versus balloon kyphoplasty in the reduction of vertebral compression fractures (SAKOS study). Spine J. Nov 2019; 19(11): 1782-1795. PMID 31325625
- Pron G, Holubowich C, Kaulback K. Vertebral Augmentation Involving Vertebroplasty or Kyphoplasty for Cancer-Related Vertebral Compression Fractures: A Systematic Review. Ont Health Technol Assess Ser. 2016; 16(11): 1-202. PMID 27298655
- Berenson J, Pflugmacher R, Jarzem P, et al. Balloon kyphoplasty versus non-surgical fracture management for treatment of painful vertebral body compression fractures in patients with cancer: a multicentre, randomised controlled trial. Lancet Oncol. Mar 2011; 12(3): 225-35. PMID 21333599

- Korovessis P, Vardakastanis K, Vitsas V, et al. Is Kiva implant advantageous to balloon kyphoplasty in treating osteolytic metastasis to the spine? Comparison of 2 percutaneous minimal invasive spine techniques: a prospective randomized controlled short-term study. Spine (Phila Pa 1976). Feb 15 2014; 39(4): E231-9. PMID 24253785
- Petersen A, Hartwig E, Koch EM, et al. Clinical comparison of postoperative results of balloon kyphoplasty (BKP) versus radiofrequency-targeted vertebral augmentation (RF-TVA): a prospective clinical study. Eur J Orthop Surg Traumatol. Jan 2016; 26(1): 67-75. PMID 26482590
- Feng L, Shen JM, Feng C, et al. Comparison of radiofrequency kyphoplasty (RFK) and balloon kyphoplasty (BKP) in the treatment of vertebral compression fractures: A meta-analysis. Medicine (Baltimore). Jun 2017; 96(25): e7150. PMID 28640091
- Yi X, Lu H, Tian F, et al. Recompression in new levels after percutaneous vertebroplasty and kyphoplasty compared with conservative treatment. Arch Orthop Trauma Surg. Jan 2014; 134(1): 21-30. PMID 24287674
- ACR-ASNR-ASSR-SIR-SNIS Practice Parameter for the Performance of Vertebral Augmentation. Available at https://www.acr.org/-/media/ACR/Files/Practice-Parameters/VerebralAug.pdf.
- American Academy of Orthopaedic Surgeons (AAOS). The treatment of symptomatic osteoporotic spinal compression fractures: Summary of Recommendations. 2010; https://www.mainegeneral.org/app/files/public/921/aaossummary.pdf.
- National Institute for Health and Care Excellence (NICE). Percutaneous vertebroplasty and percutaneous balloon kyphoplasty for treating osteoporotic vertebral compression fractures [TA279]. 2013; https://www.nice.org.uk/guidance/ta279.
- National Institute for Health and Care Excellence (NICE). Metastatic spinal cord compression in adults: risk assessment, diagnosis and management [CG75]. 2014; https://www.nice.org.uk/guidance/cg75/chapter/1- Guidance
- Jacobson RE, Palea O, Granville M. Progression of vertebral compression fractures after previous vertebral augmentation: technical reasons for recurrent fractures in a previously treated vertebra. Cureus. 2017 Oct 16;9(10):e1776. doi 10.7759/cureus.1776.
- Kasperk C, Grafe IA, Schmitt S, Nöldge G, Weiss C, Da Fonseca K, et al. Three-year outcomes after kyphoplasty in patients with osteoporosis with painful vertebral fractures. J Vasc Interv Radiol. 2010 May;21(5):701-9. Epub 2010 Mar 20.
- Kasperk C, Hillmeier J, Noldge G, Grafe IA, DaFonseca K, Raupp D, et al. Treatment of painful vertebral fractures by kyphoplasty in patients with primary osteoporosis: a prospective nonrandomized controlled study. J Bone Miner Res. 2005 Apr;20(4):604-12. Epub 2004 Dec 6.
- Lavelle W, Carl A, Lavelle ED, Khaleel MA. Vertebroplasty and kyphoplasty. Med Clin North Am. 2007 Mar;91(2):299-314.
- Ledlie JT, Renfro M. Balloon kyphoplasty: one-year outcomes in vertebral body height restoration, chronic pain, and activity levels. J Neurosurg. 2003 Jan;98(1 Suppl):36-42.age 17 of 18 Coverage Policy Number: 0040

- Ledlie JT. Renfro MB. Kyphoplasty treatment of vertebral fractures: 2-year outcomes show sustained benefits. Spine. 2006 Jan 1;31(1):57-64.
- Mattie R, Laimi K, Yu S, Saltychev M. Comparing Percutaneous Vertebroplasty and Conservative Therapy for Treating Osteoporotic Comperssiona Fractures in the Thoracic and Lumbar Spine. JBJS 2016; 98: 1041-51.
- Otten LA, Bornemann R, Jansen TR, et al. Comparison of balloon kyphoplasty with the new KIVA® VCF system for the treatment of vertebral compression fractures. Pain Physician. 2013; 16:E505- E512.
- Pateder DB, Khanna AJ, Lieberman IH. Vertebroplasty and kyphoplasty for the management of osteoporotic vertebral compression fractures. Orthop Clin North Am. 2007 Jul;38(3):409-18; abstract vii.
- Rousing R, Hansen KL, Andersen MO, et al. Twelve-months follow-up in forty-nine patients with acute/semiacute osteoporotic vertebral fractures treated conservatively or with percutaneous vertebroplasty: a clinical randomized study. Spine. 2010; 35(5): 478-482.
- Savage JW, Schroeder GD, Anderson PA. Review Article: Vertebroplasy and Kyphoplasty for the
- Treatment of Osteoporotic Vertebral Compression Fractures. J Am Acad Orthop Surg 2014; 22: 653-664.
- Spivak JM, Johnson MG. Percutaneous treatment of vertebral body pathology. J Am Acad Orthop Surg. 2005 Jan-Feb;13(1):6-17.
- Taylor R. S., Fritzell, P., Taylor, R. J. Balloon kyphoplasty in the management of vertebral compression fractures: an updated systematic review and meta-analysis. Eur Spine J. Aug 2007;16(8):1085-1100.
- Taylor RS, Fritzell P, Taylor RJ. Balloon kyphoplasty in the management of vertebral compression fractures: an updated systematic review and meta-analysis. Eur Spine J. 2007 Feb 3;
- Taylor RS, Taylor RJ, Fritzell P. Balloon kyphoplasty and vertebroplasty for vertebral compression ractures: a comparative systematic review of efficacy and safety. Spine. 2006 Nov 1;31(23):2747-55.
- Tutton SM, Pflugmacher R, Davidian M, et al. KAST Study: the Kiva system as a vertebral augmentation treatment – a safety and effectiveness trial: a randomized, noninferiority trial comparing the Kiva system with balloon kyphoplasty in treatment of osteoporotic vertebral compression fractures. Spine. 2015 Jun:40(12):865-75. doi: 10.1097/BRS.0000000000000906
- U.S. Department of Health and Human Services. FDA Public Health Notification*: Complications Related to the Use of Bone Cement and Bone Void Fillers in Treating Compression Fractures of the Spine. October 31, 2002; Updated May 7, 2004.
- Wardlaw D, Cummings SR, Van Meirhaeghe J, Bastian L, Tillman JB, Ranstam J, et al. Efficacy and safety of balloon kyphoplasty compared with non-surgical care for vertebral compression fracture: a randomised controlled trial. Lancet. 2009 Mar 21;373(9668):1016-24. Epub 2009 Feb 24.

- Washington State Health Care Authority. Vertebroplasty, kyphoplasty and Sacroplasty Health Technology Assessment. Olympia WA: Health Technology Assessment Program, 2010 Nov.
- Tomasian A., Wallace AN., Jennings JW. Benign Spine Lesions: Advances in Techniques for Minimally Invasive Percutaneous Treatment. May 2017.

POLICY HISTORY		
Date	**Reason**	**Action**
April 2022	Annual Review	Policy Revised
April 2021	Annual Review	Policy Revised
June 2020	Interim Review	Policy Revised
April 2020	Annual Review	Policy Revised
April 2019	Annual Review	Policy Revised
April 2018	Annual Review	Policy Revised
April 2017		New Policy

New information or technology that would be relevant for Wellmark to consider when this policy is next reviewed may be submitted to:

Wellmark Blue Cross and Blue Shield
Medical Policy Analyst
PO Box 9232
Des Moines, IA 50306-9232

*CPT® is a registered trademark of the American Medical Association.