6.01.25	Percutaneous Vertebroplasty and Sacroplasty		
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Policy Statement

Percutaneous vertebroplasty may be considered **medically necessary** for the treatment of **any** of the following indications:

I. Symptomatic osteoporotic vertebral fractures that have failed to respond to conservative treatment (e.g., analgesics, physical therapy, and rest) for at least 6 weeks
II. Severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies
    A. Vertebral eosinophilic granuloma with spinal instability
    B. Vertebral hemangiomas with **both** of the following:
        1. Aggressive signs (e.g., myelopathy, radiculopathy, bone fracture, collapse or destruction)
        2. Radiation therapy has failed to relieve symptoms

Percutaneous vertebroplasty may be considered **medically necessary** for the treatment of symptomatic osteoporotic vertebral fractures that are less than 6 weeks in duration that have led to hospitalization or persist at a level that prevents ambulation.

Percutaneous vertebroplasty is considered **investigational** for all other indications, including use in acute vertebral fractures due to osteoporosis or trauma.

Percutaneous sacroplasty is considered **investigational** for all indications, including use in **either** of the following:

I. Sacral insufficiency fractures due to osteoporosis
II. Sacral lesions due to multiple myeloma or metastatic malignancies

NOTE: Refer to Appendix A to see the policy statement changes (if any) from the previous version.

Policy Guidelines

Coding

There are CPT codes that describe vertebroplasty:

- **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)

The following are CPT category III codes for sacroplasty:

- **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

Description

Percutaneous vertebroplasty is an interventional technique involving the fluoroscopically guidedinjection of polymethylmethacrylate into a weakened vertebral body. The technique has been investigated to provide mechanical support and symptomatic relief in patients with osteoporotic vertebral compression fractures or those with osteolytic lesions of the spine (e.g., multiple myeloma, metastatic malignancies); as a treatment for sacral insufficiency fractures; and as a technique to limit blood loss related to surgery.

Related Policies

- Percutaneous Balloon Kyphoplasty, Radiofrequency Kyphoplasty, and Mechanical Vertebral Augmentation

Benefit Application

Benefit determinations should be based in all cases on the applicable contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

Some state or federal mandates (e.g., Federal Employee Program [FEP]) prohibits plans from denying Food and Drug Administration (FDA)-approved technologies as investigational. In these instances, plans may have to consider the coverage eligibility of FDA-approved technologies on the basis of medical necessity alone.

Regulatory Status

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

Polymethylmethacrylate bone cement was available as a drug product before enactment of the FDA's device regulation and was at first considered what the FDA terms a "transitional device." It was transitioned to a class III device requiring premarketing applications. Several orthopedic companies have received approval of their bone cement products since 1976. In 1999, polymethylmethacrylate was reclassified from class III to class II, which requires 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 2005. In 2005, polymethylmethacrylate bone cements such as Spine-Fix® Biomimetic Bone Cement and Osteopal® V were cleared for marketing by the FDA through the 510(k) process for the fixation of pathologic fractures of the vertebral body using vertebroplasty procedures.

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. FDA product code: NDN.

In 2009, Cortoss® (Stryker) Bone Augmentation Material was cleared for marketing by the FDA through the 510(k) process. Cortoss® is a nonresorbable synthetic material that is a composite resin-based, bis-glycidyl dimethacrylate. The FDA classifies this product as a polymethyl methacrylate bone cement.

In 2010, the Parallax® Contour® Vertebral Augmentation Device (ArthroCare) was cleared for marketing by FDA through the 510(k) process. The device creates a void in cancellous bone that can then be filled with bone cement. FDA product code: HXG.

Rationale

Background

Treatment of Vertebral Compression Fracture

Chronic symptoms do not tend to respond to the management strategies for acute pain such as bed rest, 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 does not improve 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.

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.[1,2]

Vertebral and Sacral Body Metastasis

Metastatic malignant disease of the spine generally involves the vertebrae/sacrum, with pain being the most frequent complaint.

Treatment of Vertebral and Sacral Body Metastasis

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

Percutaneous Vertebroplasty

Vertebroplasty is a surgical procedure that involves the injection of synthetic cement (e.g., polymethylmethacrylate, bis-glycidal dimethacrylate [Cortoss][3]) 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.

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,[4,5] it is most often described as a minimally invasive alternative to conservative management [6,7,8] 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.

Literature Review

Evidence reviews assess the clinical evidence to determine whether the use of technology improves the net health outcome. Broadly defined, health outcomes are length of life, quality of life, and ability to function, including benefits and harms. Every clinical condition has specific outcomes that are important to patients and managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of technology, 2 domains are examined: the relevance, and quality and credibility. To be relevant, studies must represent 1 or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice.

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 women and approximately one-quarter of men 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 1 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 patients 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 patients 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. Patients 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 patient, 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,[9.] the visual analogue scale,[10.] and QUALEFFO (a quality of life questionnaire in patients 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. The Roland-Morris Disability Questionnaire 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." With 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.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess long-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

This evidence review was informed by a TEC Assessment (2000), which was updated periodically through 2010. [11.,12.,13.,14.,15.,16.] Subsequent evidence includes a number of RCTs, 2 of which included a sham control, and numerous RCTs that compared vertebroplasty with conservative management.

Review of Evidence

Systematic Reviews

Buchbinder et al (2018) published a Cochrane review of the literature up to November 2014.[17] 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). 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.

Staples et al (2011) 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.[18] 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.

Xie et al (2017), in a meta-analysis of RCTs, evaluated the efficacy and safety in percutaneous vertebroplasty and conservative treatment for patients with osteoporotic vertebral compression fractures.[19] 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.

Hinde et al (2020), 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.[20] 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.
Zhang et al (2020), in a meta-analysis of RCTs, assessed the efficacy of percutaneous vertebroplasty versus conservative treatment for patients with osteoporotic vertebral compression fractures.[21] 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.

Chang et al (2021), 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.[22] 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.

Table 1. Characteristics of Systematic Reviews and Meta-Analyses on Percutaneous Vertebroplasty for Vertebral Compression Fractures of Between 6 Weeks and 1 Year Old

Study	Dates	Trials	Participants	Intervention	N (Range)	Design
Buchbinder et al (2018)[17]	2007-2016	21	Patients with osteoporotic vertebral fractures (mean age ranged from 63.3 to 80 years); symptom duration ranged from 1 week to ≥6 months.	Vertebroplasty	2862 (46-404)	RCT
Staples et al (2011)[18]	NR	2	Participants with 1-2 painful osteoporotic vertebral fractures >12 months duration and unhealed, as confirmed by MRI, were randomly assigned to vertebroplasty or to a sham procedure.	Vertebroplasty vs. placebo (5 studies); kyphoplasty (7 studies); facet joint steroid injection (1)	209 (78-131)	RCT
Xie et al (2017)[19]	NR-2017	13	Patients with OVCFs	PVP vs. conservative treatment	2561 (NR)	RCT
Hinde et al (2020)[20]	NR-2018	7	Patients with OVCFs	Vertebral augmentation (vertebroplasty or balloon kyphoplasty) vs. nonsurgical management	2,089,944 (NR)	Retrospective and cohort studies
Zhang et al (2020)[21]	NR-2018	10	Patients with OVCFs	PVP vs. conservative treatment	NR	RCT
Chang et al (2021)[22]	NR-2020	56	Patients with OVCFs	Vertebroplasty vs. conservative treatment (15 studies); kyphoplasty (24 studies)	6974 (14-191)	RCT, cohort studies

NR: not reported; OVCF: osteoporotic vertebral compression fracture; PVP: percutaneous vertebroplasty; RCT: randomized controlled trial

Table 2. Results of Systematic Reviews and Meta-Analyses on Percutaneous Vertebroplasty for Vertebral Compression Fractures of Between 6 Weeks and 1 Year Old

Study	Quality of Life	New Fractures
	QUALEFFO	
Buchbinder et al (2018)[17.]		
Placebo group at 1-month, score (N)	4.58 (71)	NR
Vertebroplasty group at 1-month, score (N)	5.38 (71)	NR
Absolute change between groups	0.4% worse (5% worse-5% better [n=71])	NR
Relative change between groups	0.7% worse (9% worse-8% better [n=71])	NR
N. Intervention group (%)	NR	28 (19.58)
N. Placebo group (%)	NR	19 (50.00)
RR (CI)	NR	1.47 (0.39 to 5.50)
	Duration of Pain	
Staples et al (2011)[18.]		
Mean change score (SD) of pain, at 2 weeks, PVP vs placebo	2.2 (2.8) vs. 2.5 (3.0)	NR
Adjusted between group difference (CI) at 2 weeks	~0.2 (~0.9-0.6)	
Mean change score (SD) of pain, at 1 month, PVP vs placebo	2.08 (3.0) vs. 2.2 (3.2)	NR
Adjusted between group difference (CI) at 2 weeks	0.6 (~0.2-1.4)	
	Pain relief	
Xie et al (2017)[19.]	N=1231	NR
At 1-week (vertebroplasty superior), MD (CI)	1.36 (0.55 to 2.17)	NR
At 1-month (vertebroplasty superior), MD (CI)	1.56 (0.43 to 2.70)	NR
At 6-months (vertebroplasty inferior), MD (CI)	-1.59 (-2.9 to -0.27) p<0.05	NR
Total (vertebroplasty superior), MD (CI)	-5.03 (7.94 to -2.12)	NR
	Mortality	
Hinde et al (2020)[20.]		
Mortality, 2-year follow up, HR (CI), vertebral augmentation vs nonsurgical management	0.70 (0.69, 0.71)	NR
Mortality, 5-year follow up, HR (CI), vertebral augmentation vs nonsurgical management	0.79 (0.62, 0.9999)	NR
	Pain relief and quality of life	
Zhang et al (2020)[21.]		
Pain relief at 1 week (PVP superior), MD (CI)	1.67 (0.84 to 2.51) p<0.0001	
Pain relief at 1 month (PVP superior), MD (CI)	1.98 (0.61 to 3.36) p=0.005	
Pain relief at 3 months, MD (CI)	−0.44 (−2.03 to 1.15)	OR, 1.09 (0.72 to 1.64)
EuroQol questionnaire (PVP superior), MD (CI)	0.11 (0.01 to 0.20) p=0.03	
Quality of Life Questionnaire of the European Foundation for Osteoporosis, MD (CI)	−7.29 (−12.60 to −1.99)	
Roland-Morris Disability Questionnaire, MD (CI)	0.66 (−2.00 to 3.33)	
	Pain and disability relief	
Chang at al (2021)[22.]		
Treatment effect for visual analog scale, mean (CI), vertebroplasty vs conservative treatment	-0.66 (-1.10 to -0.21)	OR, 1.09 (0.79 to 1.50)
Treatment effect for visual analog scale, mean (CI), vertebroplasty vs kyphoplasty	0.28 (-0.06, 0.61)	OR, 0.99 (0.74 to 1.33)
Treatment effect for ODI, mean (CI), vertebroplasty vs conservative treatment	-5.27 (-9.19, -1.35)	
Treatment effect for ODI, mean (CI), vertebroplasty vs kyphoplasty	1.23 (-1.59, 4.04)	

CI: 95% confidence interval; HR: hazard ratio; MD: mean difference; NR: not reported; ODI = Oswestry Disability Index;OR: odds ratio; PVP: percutaneous vertebroplasty; QUALEFFO-41 Questionnaire: a quality of life questionnaire in patients with vertebral fractures; RR: relative risk; SD: standard deviation.

Randomized Controlled Trials

Vertebroplasty Versus Medical Management With Sham Controls

Three sham-controlled trials compared vertebroplasty with medical management using a sham control (that included local anesthetic), which mimicked the vertebroplasty procedure up to the point of cement injection.[23,24] Buchbinder et al (2009) 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.[23] 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. Kroon et al (2014) reported results of the same trial at 12 and 24 months, maintaining blinding throughout the follow-up period.[25] 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.

Kallmes et al (2009) 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).[24] 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 postprocedure. 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.[26]

For the primary endpoints at 1 month, there were no significant between-group differences. There was a trend toward a higher clinically meaningful improvement in pain at 1 month (30% reduction from baseline) in the vertebroplasty group (64% vs. 48%, respectively; p=0.06). At 3 months, 51% from the control group and 13% in the vertebroplasty group crossed over (p<0.001). Comstock et al (2013) 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.

Firanescu et al (2018) published the results of a randomized, double-blind, sham-controlled clinical trial performed in 4 community hospitals in the Netherlands from 2011 to 2015.[28] 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. These changes in visual analogue scale scores did not, however, differ statistically significantly between the groups during 12 months' follow-up.

Table 3. Summary of Characteristics of Key RCT Comparing Vertebroplasty Versus Medical Management With Sham Controls

Study	Countries	Sites	Dates	Participants (N)	Interventions	
					Active (n)	Comparator (n)
Buchbinder et al (2009)[23.]	US	4	2003-2008	Patients with 1-2 painful OCVF, duration <1 year	Vertebroplasty (38)	sham procedure[1] (40)
Kallmes et al (2009)[24.]	US, UK, Aus	10	2004-2008	Participants with 1-3 painful OCVF, pain ≤ 12 mo, current pain VAS ≥ 3	Vertebroplasty (68)	sham procedure[1] (63)
Firanescu et al (2018)[28.]	Netherlands	4	2011-2015	Participants with acute OCVF	Vertebroplasty (91)	sham procedure[1] (89)

OVCF: osteoporotic vertebral compression fracture; RCT: randomized controlled trial; VAS: visual analogue scale.
[1] Injection of local anesthetic into the facet capsule and/or periosteum.

Table 4. Summary of Results of Key RCT Comparing Vertebroplasty Versus Medical Management with Sham Controls

Study	VAS	RMDQ
Buchbinder et al (2009)[23.]	N=73, at 3-months	
Intervention (mean±SD)	Reduction: 2.6±2.9	
Control (mean±SD)	Reduction: 1.9±3.3	
Adjusted between-group difference (CI)	0.6 (-0.7-1.8)	
Kallmes et al (2009)[24.]		
Day 14 Mean difference between groups (CI)	0.1 (-0.8-1.1)	-0.6 (-2.4-1.2)
P-value	0.77	0.35
Month 1 Mean difference between groups (CI)	0.7 (-0.3-1.70)	0.7 (-1.3-2.8)
P-value	0.19	0.49
Firanescu et al (2018)[28.]	N=180	
Day 1 Mean difference between groups (CI)	-0.43 (-1.17 - 0.31)	
Week 1 Mean difference between groups (CI)	-0.11 (-0.85 - 0.63)	
Month 1 Mean difference between groups (CI)	0.41 (-0.33 - 1.15)	
Month 3 Mean difference between groups (CI)	0.21 (-0.54 - 0.96)	
Month 6 Mean difference between groups (CI)	0.39 (-0.33 - 1.15)	
Month 12 Mean difference between groups (CI)	0.45 (-0.37-1.24)	

CI: 95% confidence interval; NR: not reported; RCT: randomized controlled trial; RMDQ: Roland-Morris Disability Questionnaire; SD: standard deviation; VAS: visual analogue score.

Table 5. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-up[e]
Buchbinder et al (2009)[23.]					
Kallmes et al (2009)[24.]				3. No reporting of harms. 5. investigator modified pain window from 6 to 9 weeks.	
Firanescu et al (2018)[28.]	2. Lack of screening for co-occurring pain conditions.			5. investigator modified	

	2. MRI was not conducted.				pain window from 6 to 9 weeks.	

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
[a] Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
[b] Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
[c] Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
[d] Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not established and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
[e] Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 6. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Follow-Up[d]	Power[e]	Statistical[f]
Buchbinder et al (2009)[23.]			2. 30% of eligible participants declined to participate, selection bias can not be ruled out.			
Kallmes et al (2009)[24.]		1. At 14 days, > 50% of participants in either arm correctly identified their intervention assignment.		4. Due to high crossover the group differences in outcomes were complicated.		
Firanescu et al (2018)[28.]	4. Screening logs not retained.					

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
[a] Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
[b] Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
[c] Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
[d] Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
[e] Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
[f] Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4.Comparative treatment effects not calculated.

Vertebroplasty Versus Medical Management Without Sham Controls

Chen et al (2014) reported on a nonblinded RCT comparing vertebroplasty with conservative management.[29.] 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).
Farrokhi et al (2011) reported on a blinded RCT that compared vertebroplasty with optimal medical management in 82 patients.[30] 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. 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.

Table 7. Summary of Key RCT Characteristics - Vertebroplasty Versus Medical Management Without Sham Controls

Study	Countries	Sites	Dates	Participants (N)	Interventions	
					Active	*Comparator*
Chen et al (2014)[29]	China	1	2007-2012	Patients with chronic compression fractures confirmed by MRI and persistent severe pain for <3 months (89)	Vertebroplasty	Conservative Management
Farrokhi et al (2011)[30]	Iran	1	2004-2005	Patients with painful osteoporotic vertebral compression fractures refractory to analgesic therapy for >4, but <1 year (82)	Vertebroplasty	Optimal Medical Management

MRI: magnetic resonance imaging; RCT: randomized controlled trial.

Table 8. Summary of Key RCT Results

Study	Pain Score	ODI score	RMDQ
	Overall pain (scale 0-10)		
Chen et al (2014) (N=89)[29]			
Intervention Group, Pooled at 1-year	2.5	15.0	8.1
Control Group, Pooled at 1-year	4.1	32.1	10.7
P-value	<0.001	<0.001	<0.001
Farrokhi et al (2011)[30]	VAS Score		
Week 1 Mean difference between groups (CI); p-value	-3.1 (-3.72 to -2.28); <0.001	-14.0 (-15.00 to -12.82); <0.028	
Month 2 Mean difference between groups (CI); p-value	-2.9 (-4.9 to -0.82); <0.011	-15.0 (-16.76 to -13.24); <0.019	
Month 6 Mean difference between groups (CI); p-value	-1.9 (-3.25 to -0.55); <0.021	-11.0 (-12.17 to -7.83); <0.011	

Month 12 Mean difference between groups (CI); p-value	-1.9 (-2.9 to 0.9); <0.11	-12.0 (-13.5 to -11.5); <0.021

CI: confidence interval;; ODI: Oswestry Disability Index, RCT: randomized controlled trial; RMDQ: Roland-Morris Disability Questionnaire; VAS: visual analogue scale.

Table 9. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Chen et al (2014)[29.]			3. Investigator modified duration of the conservative therapy from 6 to 4 weeks		
Farrokhi et al (2011)[30.]				4. Language translation of Oswestry scale not validated.	

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
[a] Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
[b] Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
[c] Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
[d] Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
[e] Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 10. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Follow-Up[d]	Power[e]	Statistical[f]
Chen et al (2014)[29.]		1,2. This study was not blinded.				
Farrokhi et al (2011)[30.]						

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
[a] Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
[b] Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
[c] Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
[d] Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
[e] Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
[f] Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4.Comparative treatment effects not calculated.

Nonrandomized Comparative Studies

Edidin et al (2011, 2015) reported on mortality risk rates in Medicare patients who had vertebral compression fractures and were treated with vertebroplasty, kyphoplasty, or nonoperatively.[31,32.] 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).

Lin et al (2017) 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.[33] 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.

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. Six meta-analysis studies have been published, but all of them 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. Also, 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 patients screened who participated in the trial, the volume of polymethylmethacrylate injected, and the inclusion of patients 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. Patients 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.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess long-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence
Randomized Controlled Trials
Vertebroplasty Versus Medical Management With Sham Controls
Clark et al (2016) reported on results from the Safety and Efficacy of Vertebroplasty of Acute Painful Osteoporotic Fractures (VAPOUR) trial (see Table 11).[34.] 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. This trial followed a similar protocol as that used in the Kallmes et al (2009) trial (discussed above). The primary outcome (the percentage of patients with a numeric rating scale score <4 out of 10 at 14 days postprocedure) was met in a greater percentage of patients in the vertebroplasty group (44%) than in the sham control group (21%). This between-group difference was maintained through 6 months.

Other outcome measures were significantly improved in the vertebroplasty group at 1 or both of the time points (see Table 11). The benefit of vertebroplasty was found predominantly in the thoracolumbar subgroup, with 48% (95% CI, 27% to 68%) more patients meeting the primary endpoint (61% in the vertebroplasty group vs. 13% in the control group). The investigators commented that the thoracolumbar junction is subject to increased dynamic load, and fractures at this junction have the highest incidence of mobility. No benefit from vertebroplasty was found in the non-thoracolumbar subgroup. Postprocedural hospital stay was reduced from a mean of 14 days in the control group to 8.5 days after vertebroplasty, even though physicians who determined the discharge date remained blinded to treatment. In the vertebroplasty group, there were 2 serious adverse events due to sedation and transfer to the radiology table. In the control group, 2 patients developed spinal cord compression; 1 underwent decompressive surgery and the other, not a surgical candidate, became paraplegic.

Vertebroplasty Versus Medical Management Without Sham Controls

Klazenet al (2010) 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.[35.] 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.

Yi et al (2014) 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).[36.] 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).

Leali et al (2016) 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.[37.] 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.

Yang et al (2016) 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.[38.] 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.

Table 11. Summary of Key RCT Characteristics Involving Vertebroplasty Versus Medical Management without Sham Controls

Study; Trial	Countries	Sites	Dates	Participants (N)	Interventions	
					Active (n)	*Comparator (n)*
Klazen et al (2010)[35.]	EU	6	2005-2008	Patients >50 years with radiographically confirmed VCF, back pain for <6 weeks, VAS >5	Vertebroplasty (101)	Medical Management without Sham Controls (101)
Yi et al (2014)[36.]	China	1	2005-2009	Patients with OCVF	PVP or PKP(169)	Conservative treatment(121)
Leali et al (2010)[37.]	International	4	NR	Post-menopausal women with 1 thoracic or lumbar symptomatic OVCF caused by primary or secondary osteoporosis.	PVP including analgesic and osteoporosis medication (200)	Conservative care including analgesic and osteoporosis medication (200)
Yang et al (2015)[38.]	China	1	2009-2011	Patients >70 years with acute OVCF, severe pain from minor or mild trauma	PVP (56 at 1 y)	Conservative treatment (51 at 1 y)

NR: not reported; OVCF: osteoporotic vertebral compression fractures; PKP; percutaneous kyphoplasty; PVP: percutaneous vertebroplasty; RCT: randomized controlled trial; VCF: vertebral compression fracture; VAS: visual analog scale.

Table 12. Summary of Key RCT Results Involving Vertebroplasty Versus Medical Management without Sham Controls

Study	VAS	Quality of Life	Refracture Rate
Klazen et al (2010)[35.]			
Mean difference between groups in reduction of mean VAS score from baseline		RMDQ[1]	Median follow-up of 12.0 months (range: 1-24)
Month 1 (CI)	2.0 (1.13-2.80)	PVP: 12.5	PVP: 18 (16.48%)
p-value	< 0.0001	Control: 13.5	Control: 30 (24.71%)
Month 12 (CI)	2.0 (1.13-2.80)	PVP: 9	
p-value	<0.0001	Control: 12	
Yi et al (2014)[36.]			
Month 12 (%)	-	-	PVP/PKP: 18 (8.28%)
	-	-	Control: 24 (19.83%)
	-	-	Time interval of recompression
Intervention	-	-	9.7 ± 17.8 months
Control			22.4 ± 7.99 months
p-value			0.017
Leali et al (2016)[37.]		ODI, %	
Intervention 24 hours after surgery, mean	2.3	31.7	-
p-value	≤0.023	≤0.012	
Yang et al (2015)[238.]			
Analysis of variance models, Month 1 (SD)	PVP: 2.4±1 Control: 4.8±1	PVP: 48±10 Control: 71±7	
Analysis of variance models, Month 12 (SD)	PVP: 1.8±0.3	PVP: 30±5	PVP: 5 (8.9%)
p-value	Control: 3±0.5	Control:-	Control: 4 (7.8)<0.0001

CI: 95% confidence interval; ODI: Oswestry Disability Index; PKP: percutaneous kyphoplasty; PVP: percutaneous vertebroplasty; RCT: randomized controlled trials; RMDQ: Roland-Morris Disability Questionnaire; VAS: visual analogue scale; SD: standard deviation.

[1]The RMDQ results from the Klazen paper are based on estimates due to the graphical presentation of the results, rather than the reporting of the numerical values.

[2] The results from the Yang paper are based on estimates due to the graphical presentation of the results; numerical results not reported.

Table 13. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Klazen et al (2010)[35.]				3. None reported	
Yi et al (2014)[36.]	4. Selection criteria for PVP or PKP unclear, some patients had > fracture				
Leali et al (2010)[37.]	1. Limited to post-menopausal women				1,2 Follow-up period limited to < 6 months
Yang et al (2015)[38.]	4. Study population limited to > 70 years of age at single spine center				

PVP: percutaneous vertebroplasty; PKP: percutaneous kyphoplasty.
The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
[a] Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
[b] Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
[c] Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
[d] Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
[e] Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 14. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Follow-Up[d]	Power[e]	Statistical[f]
Klazen et al (2010)[35.]		1,2. No masking.				
Yi et al(2014)[36.]						
Leali et al (2010)[37.]		1,2,3, unclear if masking occurred	2. Outcomes beyond 48 hours post-surgery not reported.			
Yang et al (2015)[38.]		1,2,3 No masking				3. Results reported only in graphic form

The study limitations stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.
[a] Allocation key: 1. Participants not randomly allocated; 2. Allocation not concealed; 3. Allocation concealment unclear; 4. Inadequate control for selection bias.
[b] Blinding key: 1. Not blinded to treatment assignment; 2. Not blinded outcome assessment; 3. Outcome assessed by treating physician.
[c] Selective Reporting key: 1. Not registered; 2. Evidence of selective reporting; 3. Evidence of selective publication.
[d] Follow-Up key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. Not intent to treat analysis (per protocol for noninferiority trials).
[e] Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.

[f] Statistical key: 1. Intervention is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Intervention is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4.Comparative treatment effects not calculated.

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 patients 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 patients.

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.[1,] Osteoporosis is the most common risk factor for sacral insufficiency fractures. Lourie (1982) described spontaneous fracture of the sacrum in patients with osteoporosis as presenting as lower back and buttock pain with or without referred pain in the legs.[39,] 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 patients 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.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

1. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.
2. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
3. To assess long-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
4. Studies with duplicative or overlapping populations were excluded.

Review of Evidence

Observational Studies

Sacroplasty is an evolving technique achieved using numerous methods (short-axis, long-axis, balloon-assisted short-axis, iliosacral screws). No randomized trials of sacroplasty were identified. Frey et al (2008) conducted the largest prospective observational cohort study, assessing 52 consecutive patients undergoing sacroplasty for sacral insufficiency fractures using the short-axis technique.[40.] Patients had a mean age of 75.9 years, mean duration of symptoms of 34.5 days (range, 4-89 days), and mean visual analogue scale score of 8.1 at baseline. Improvements in visual analogue scale scores were measured at 30 minutes and 2, 4, 12, 24, and 52 weeks postprocedure. At each interval, statistically significant improvements over baseline were observed and maintained through 52 weeks.

Kortman et al (2013) reported on the largest series, a retrospective multicenter analysis.[41.] 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.

Frey et al (2017) reported on patients treated with percutaneous sacroplasty, particularly the long-term efficacy of sacroplasty versus nonsurgical management.[42.] 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. Mean pretreatment visual analogue scale for the sacroplasty group was 8.29; for the nonsurgical treatment group, it was 7.47. Both forms of treatment resulted in significant visual analogue scale improvement from pretreatment to the 2-year follow-up ($p<0.001$). However, the sacroplasty treatment group experienced significant visual analogue scale score improvement consistently at many of the follow-up points (pretreatment to post [$p<0.001$]; posttreatment through 2 weeks [$p>0.001$]; 12 weeks through 24 weeks [$p=0.014$]; 24 weeks through 1 year [$p=0.002$]). Meanwhile, the group with nonsurgical treatment only experienced 1 significant pain improvement score, which was at the 2-week follow-up posttreatment ($p=0.002$). One major limitation of this study was that the nonsurgical treatment group was not followed up at the 10-year mark whereas the sacroplasty group did receive follow-up.

There are several retrospective reviews with roughly 50 patients per publication. One reported by Dougherty et al (2014) described a series of 57 patients treated with sacroplasty for sacral insufficiency fractures.[43.] 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%.

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.[44,] Performing sacroplasty only on zone 1 fractures can minimize these risks.[45,]

Section Summary: Percutaneous Sacroplasty
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 patients and the retrospective nature of the evidence base, harms associated with sacroplasty have not been adequately studied. The small numbers of treated patients leave uncertainty regarding the impact of sacroplasty on health outcomes.

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 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 2 with sham controls, the efficacy of vertebroplasty for painful osteoporotic compression fractures remains uncertain. Two meta-analysis studies, which included the 2 sham-controlled trials have demonstrated mixed results. The 2 studies 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.

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 a retrospective series of 243 patients. 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. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

Supplemental Information
The purpose of the following information is to provide reference material. Inclusion does not imply endorsement or alignment with the evidence review conclusions.

Clinical Input From Physician Specialty Societies and Academic Medical Centers
While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

2014 Input
In response to requests from Blue Cross Blue Shield Association, input was received from 2 physician specialty societies and 3 academic medical centers in 2014. Input was sought on the treatment of acute vertebral fractures when there is severe pain that has led to hospitalization or persists at a level that prevents ambulation, and on the treatment of traumatic fractures that have remained symptomatic after 6 weeks of conservative treatment. Input on these issues was mixed.

2008 Input
In response to requests, from Blue Cross Blue Shield Association, input was received from 5 physician specialty societies and 2 academic medical centers in 2008. Unsolicited input was received from a sixth physician specialty society. All reviewers disagreed with the proposed policy and provided references in support of the use of vertebroplasty. Vertebroplasty has been investigated as an intervention to provide mechanical support and symptomatic relief in patients with an osteoporotic vertebral compression fracture and in those with osteolytic lesions of the spine (i.e., multiple myeloma, metastatic malignancies). Clinical input obtained in 2008 provided uniform support for the use of vertebroplasty in painful osteoporotic fractures. Reconsideration of the available evidence and evaluation of the input led to a conclusion that, consistent results of numerous case series, including large prospective reports, the evidence was sufficient to determine that vertebroplasty is a reasonable treatment option in patients with vertebral fractures who have failed 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 the osteoporotic vertebral fracture to support its use in osteolytic lesions of the spine (e.g., multiple myeloma, metastatic malignancies).

Practice Guidelines and Position Statements
Guidelines or position statements will be considered for inclusion in ‘Supplemental Information' if they were issued by, or jointly by, a US professional society, an international society with US representation, or National Institute for Health and Care Excellence (NICE). Priority will be given to guidelines that are informed by a systematic review, include strength of evidence ratings, and include a description of management of conflict of interest.

American College of Radiology
In 2020 , the American College of Radiology (ACR) revised its Appropriateness Criteria for the use of percutaneous vertebral aug mentation in the management of vertebral compression fractures.[46,] Table 15 shows the appropriateness categories for each variant.

Table 15. ACR Appropriateness Criteria for the Use of Percutaneous Vertebral Augmentation for the Management of Vertebral Compression Fractures

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

ACR: American College of Radiology; CT: computed tomography; MRI: magnetic resonance imaging.

In 2014, the ACR and 7 other medical specialty associations, including the Society for Interventional Radiology, updated a 2012 joint position statement on percutaneous vertebral augmentation.[11.] The statement indicated that "percutaneous vertebral augmentation with the use of vertebroplasty or kyphoplasty is a safe, efficacious, and durable procedure in appropriate patients with symptomatic osteoporotic and neoplastic fractures, when performed in accordance with published standards...only when nonoperativ e medical therapy has not provided adequate pain relief or pain is significantly altering the patient's quality of life. "

Society of Interventional Radiology

In a 2014 quality improvement guideline for percutaneous vertebroplasty from the Society of Interventional Radiology, failure of medical therapy was defined as follows[47.]:

1. "For a patient rendered nonambulatory as a result of pain from a weakened or fractured vertebral body, pain persisting at a level that prevents ambulation despite 24 hours of analgesic therapy;
2. For a patient with sufficient pain from a weakened or fractured vertebral body that physical therapy is intolerable, pain persisting at that level despite 24 hours of analgesic therapy; or
3. For any patient with a weakened or fractured vertebral body, unacceptable side effects such as excessive sedation, confusion, or constipation as a result of the analgesic therapy necessary to reduce pain to a tolerable level."

American Academy of Orthopaedic Surgeons

In 2011, the American Academy of Orthopaedic Surgeons (AAOS) published practice guidelines on the treatment of osteoporotic spinal compression fractures.[48.] The AAOS approved "a Strong recommendation against the use of vertebroplasty for patients who present with an acute osteoporotic spinal compression fracture and are neurologically intact."

National Institute for Health and Care Excellence

In 2003, the National Institute for Health and Care Excellence (NICE) concluded in its guidance on percutaneous vertebroplasty that 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...."[49.] The guidance also recommended that the procedure be limited to patients whose pain is refractory to more conservative treatment. A 2013 NICE guidance indicated that percutaneous vertebroplasty and percutaneous balloon kyphoplasty "are recommended as options for treating osteoporotic vertebral compression fractures" in persons having "severe, ongoing pain after a recent, unhealed vertebral fracture despite optimal pain management" and whose "pain has been confirmed to be at the level of the fracture by physical examination and imaging."[50.]

In 2008, NICE issued guidance on the diagnosis and management of adults with metastatic spinal cord compression.[51.] 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."

U.S. Preventive Services Task Force Recommendations

Not applicable.

Medicare National Coverage

There is no national coverage determination. In the absence of a national coverage determination, coverage decisions are left to the discretion of local Medicare carriers.

Ongoing and Unpublished Clinical Trials

Some currently unpublished trials that might influence this review are listed in Table 16.

Table 16. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Ongoing			
NCT02902250	The Comparative Study About the Effect of Vertebral Body Decompression Procedure and Conservative Treatment for Benign Vertebral Compression Fracture - Prospective Randomized Control Study	80	Dec 2021
NCT03617094	Early Percutaneous Vertebroplasty Versus Standard Conservative Treatment in Thoracolumbar Vertebral Fractures. Monocentric, Prospective, Randomised and Compared Clinical Study	42	Oct 2020
Unpublished			
NCT02489825	Pilot Study: Does Preventive Adjacent Level Cement Augmentation Positively Affect Reoperation Rates After Osteoporotic Vertebral Compression Fractures?	100	June 2019

NCT: national clinical trial.

References

1. 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
2. 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
3. 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
4. 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
5. 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
6. 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
7. 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
8. 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
9. 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

10. Katz J, Melzack R. Measurement of pain. Surg Clin North Am. Apr 1999; 79(2): 231-52. PMID 10352653
11. 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
12. 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.
13. 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.
14. Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty for vertebral fractures caused by osteoporosis. TEC Assessments. 2010;Volume 25:Tab 9.
15. 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.
16. 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.
17. 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
18. 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
19. 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
20. 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
21. 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
22. 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
23. 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
24. 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
25. 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
26. 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

27. 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
28. 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
29. 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
30. 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
31. 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
32. 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
33. 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
34. 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
35. 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
36. 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
37. 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
38. 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
39. Lourie H. Spontaneous osteoporotic fracture of the sacrum. An unrecognized syndrome of the elderly. JAMA. Aug 13 1982; 248(6): 715-7. PMID 7097924
40. 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
41. 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
42. 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
43. 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
44. Zaman FM, Frey M, Slipman CW. Sacral stress fractures. Curr Sports Med Rep. Feb 2006; 5(1): 37-43. PMID 16483515

45. 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
46. 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
47. 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
48. 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
49. National Institute for Health and Care Excellence (NICE). Percutaneous vertebroplasty [IPG12]. 2003; https://www.nice.org.uk/guidance/ipg12. Accessed February 24, 2021.
50. 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.
51. 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.
52. Blue Cross Blue Shield Association. Medical Policy Reference Manual, No. 6.01.25 (April 2021).

Documentation for Clinical Review

Please provide the following documentation:

- History and physical and/or consultation notes including:
  - Reason for procedure
  - Diagnoses
  - Description of prior treatment and response (including time frame of treatment)
  - Imaging report(s)

Post Service (in addition to the above, please include the following):

- Procedure report

Coding

This Policy relates only to the services or supplies described herein. Benefits may vary according to product design; therefore, contract language should be reviewed before applying the terms of the Policy.

The following codes are included below for informational purposes. Inclusion or exclusion of a code(s) does not constitute or imply member coverage or provider reimbursement policy. Policy Statements are intended to provide member coverage information and may include the use of some codes for clarity. The Policy Guidelines section may also provide additional information for how to interpret the Policy Statements and to provide coding guidance in some cases.

Type	Code	Description
CPT®	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

Type	Code	Description
	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
	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)
HCPCS	None	

Policy History

This section provides a chronological history of the activities, updates and changes that have occurred with this Medical Policy.

Effective Date	Action
02/14/2001	New Policy Adoption Policy for Vertebroplasty
10/24/2001	New Policy Adoption Policy for Kyphoplasty
11/05/2002	Policy Revision Addition of the FDA notification to description
03/01/2005	Policy Revision MPC Adoption CTAF Consent review of BCBSA TEC 2004 Vol. 24, No. 12 & 13. Policy Updated.
10/01/2005	Policy Name Change Policy review, title modifications
12/01/2005	Policy Revision MPC Adoption CTAF Consent review of BCBSA TEC Vol.20, No. 6 & 7. Policy Updated.
12/01/2006	BCBSA Medical Policy adoption MPC adopted BCBSA MPP review for Percutaneous Vertebroplasty 4:2006 & Percutaneous Kyphoplasty
10/15/2007	Policy Revision Policy changed based on expert input and evidence review. Approved under certain conditions (see policy for details).
06/19/2009	Policy Revision
03/30/2012	Policy Name Change Combination of two BCBSA medical policies: Percutaneous Vertebroplasty and Sacroplasty (6.01.25) and Percutaneous Kyphoplasty (6.0138).
07/06/2012	Policy title change from Percutaneous Kyphoplasty and Vertebroplasty with position change
07/13/2012	Coding Update
12/15/2014	Policy title change from Percutaneous Kyphoplasty, Vertebroplasty and Sacroplasty Policy revision with position change
04/08/2015	Coding update
08/31/2015	Policy revision without position change
01/01/2016	Coding update
07/01/2016	Clarification of policy language
05/01/2017	Policy revision without position change
07/01/2017	Policy revision without position change
06/01/2018	Policy revision without position change
06/01/2019	Policy revision without position change

Effective Date	Action
06/01/2020	Annual review. No change to policy statement. Literature review updated.
06/01/2021	Annual review. Policy statement and literature review updated.

Definitions of Decision Determinations

Medically Necessary: Services that are Medically Necessary include only those which have been established as safe and effective, are furnished under generally accepted professional standards to treat illness, injury or medical condition, and which, as determined by Blue Shield, are: (a) consistent with Blue Shield medical policy; (b) consistent with the symptoms or diagnosis; (c) not furnished primarily for the convenience of the patient, the attending Physician or other provider; (d) furnished at the most appropriate level which can be provided safely and effectively to the patient; and (e) not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of the Member's illness, injury, or disease.

Investigational/Experimental: A treatment, procedure, or drug is investigational when it has not been recognized as safe and effective for use in treating the particular condition in accordance with generally accepted professional medical standards. This includes services where approval by the federal or state governmental is required prior to use, but has not yet been granted.

Split Evaluation: Blue Shield of California/Blue Shield of California Life & Health Insurance Company (Blue Shield) policy review can result in a split evaluation, where a treatment, procedure, or drug will be considered to be investigational for certain indications or conditions, but will be deemed safe and effective for other indications or conditions, and therefore potentially medically necessary in those instances.

Prior Authorization Requirements (as applicable to your plan)

Within five days before the actual date of service, the provider must confirm with Blue Shield that the member's health plan coverage is still in effect. Blue Shield reserves the right to revoke an authorization prior to services being rendered based on cancellation of the member's eligibility. Final determination of benefits will be made after review of the claim for limitations or exclusions.

Questions regarding the applicability of this policy should be directed to the Prior Authorization Department at (800) 541-6652, or the Transplant Case Management Department at (800) 637-2066 ext. 3507708 or visit the provider portal at www.blueshieldca.com/provider.

Disclaimer: This medical policy is a guide in evaluating the medical necessity of a particular service or treatment. Blue Shield of California may consider published peer-reviewed scientific literature, national guidelines, and local standards of practice in developing its medical policy. Federal and state law, as well as contract language, including definitions and specific contract provisions/exclusions, take precedence over medical policy and must be considered first in determining covered services. Member contracts may differ in their benefits. Blue Shield reserves the right to review and update policies as appropriate.

Appendix A

POLICY STATEMENT	
BEFORE **Red font: Verbiage removed**	**AFTER** **Blue font: Verbiage Changes/Additions**
Percutaneous Vertebroplasty and Sacroplasty 6.01.25 **Policy Statement:** Percutaneous vertebroplasty may be considered **medically necessary** for the treatment of **any** of the following indications: I. Symptomatic osteoporotic vertebral fractures that have failed to respond to conservative treatment (e.g., analgesics, physical therapy, and rest) for at least 6 weeks II. Severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies A. Vertebral eosinophilic granuloma with spinal instability B. Vertebral hemangiomas with **both** of the following: 1. Aggressive signs (e.g., myelopathy, radiculopathy, bone fracture, collapse or destruction) 2. Radiation therapy has failed to relieve symptoms Percutaneous vertebroplasty may be considered **medically necessary** for the treatment of symptomatic osteoporotic vertebral fractures that are less than 6 weeks in duration that have led to hospitalization or persist at a level that prevents ambulation. Percutaneous vertebroplasty is considered **investigational** for all other indications, including use in acute vertebral fractures due to osteoporosis or trauma. Percutaneous sacroplasty is considered **investigational** for all indications, including use in **either** of the following: I. Sacral insufficiency fractures due to osteoporosis II. Sacral lesions due to metastatic malignancies or multiple myeloma	**Percutaneous Vertebroplasty and Sacroplasty 6.01.25** **Policy Statement:** Percutaneous vertebroplasty may be considered **medically necessary** for the treatment of **any** of the following indications: I. Symptomatic osteoporotic vertebral fractures that have failed to respond to conservative treatment (e.g., analgesics, physical therapy, and rest) for at least 6 weeks II. Severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies A. Vertebral eosinophilic granuloma with spinal instability B. Vertebral hemangiomas with **both** of the following: 1. Aggressive signs (e.g., myelopathy, radiculopathy, bone fracture, collapse or destruction) 2. Radiation therapy has failed to relieve symptoms Percutaneous vertebroplasty may be considered **medically necessary** for the treatment of symptomatic osteoporotic vertebral fractures that are less than 6 weeks in duration that have led to hospitalization or persist at a level that prevents ambulation. Percutaneous vertebroplasty is considered **investigational** for all other indications, including use in acute vertebral fractures due to osteoporosis or trauma. Percutaneous sacroplasty is considered **investigational** for all indications, including use in **either** of the following: I. Sacral insufficiency fractures due to osteoporosis II. Sacral lesions due to multiple myeloma or metastatic malignancies