Policy Number	**RAD601.041**
Policy Effective Date	**02/01/2024**
Policy End Date	**12/31/2024**

Percutaneous Balloon Kyphoplasty, Radiofrequency Kyphoplasty, and Mechanical Vertebral Augmentation

Table of Contents

Related Policies (if applicable)
None

Disclaimer

Carefully check state regulations and/or the member contract.
Each benefit plan, summary plan description or contract defines which services are covered, which services are excluded, and which services are subject to dollar caps or other limitations, conditions or exclusions. Members and their providers have the responsibility for consulting the member's benefit plan, summary plan description or contract to determine if there are any exclusions or other benefit limitations applicable to this service or supply. **If there is a discrepancy between a Medical Policy and a member's benefit plan, summary plan description or contract, the benefit plan, summary plan description or contract will govern.**

Coverage

Percutaneous balloon kyphoplasty or mechanical vertebral augmentation with a United States (U.S.) Food and Drug Administration (FDA) cleared device **may be considered medically necessary** for the treatment of:

- Osteolytic vertebral metastasis, myeloma, or plasmacytoma with severe back pain related to destruction of the vertebral body **NOT** involving the major part of the cortical bone, when chemotherapy or radiation therapy has failed to relieve symptoms; OR
- Vertebral hemangiomas with severe pain or nerve compression, or aggressive radiologic signs, when radiation therapy has failed to relieve symptoms; OR
- Eosinophilic granuloma with pain and spinal instability; OR
- Vertebral compression fracture due to osteoporosis or osteopenia when **ALL** the following requirements are met:
    - Recent onset of back pain localized to the fracture site which has not responded to at least 6 weeks of conservative medical management (e.g., analgesics, physical therapy,

rest); and
- Tenderness to palpation directly over the fracture site; and
- Advanced imaging studies confirming a non-traumatic, acute compression fracture; and
- Recent imaging studies (MRI or CT) which eliminate disc herniation or other causes of spine pain; and
- Absence of imaging findings which would confer unacceptable risk to the spinal cord or related structures, such as:
    1. Spinal stenosis of greater than 20% due to retropulsed fragments; or
    2. Vertebral body collapse to less than one third (33%) original height; or
    3. Vertebral plana (collapse greater than 90%); or
    4. Anatomical damage of the vertebra that prevents safe access of the needle to the vertebral body; or
    5. Burst fracture with retropulsed fragments demonstrated by imaging.

Percutaneous balloon kyphoplasty or mechanical vertebral augmentation with an FDA cleared device **is considered experimental, investigational and/or unproven** for all other indications, including use in acute vertebral fractures due to osteoporosis or trauma.

Radiofrequency kyphoplasty **is considered experimental, investigational and/or unproven.**

Mechanical vertebral augmentation using any other device, including but not limited to vertebral body stenting **is considered experimental, investigational and/or unproven.**

Policy Guidelines

None.

Description

Percutaneous balloon kyphoplasty, radiofrequency kyphoplasty (RFK), and mechanical vertebral augmentation are interventional techniques involving the fluoroscopically guided injection of polymethylmethacrylate (PMMA) into a cavity created in the vertebral body with a balloon or mechanical device. These techniques have been investigated as options to provide mechanical support and symptomatic relief in patients with osteoporotic vertebral compression fracture or in those with osteolytic lesions of the spine (i.e., multiple myeloma, metastatic malignancies).

Background

Osteoporotic Vertebral Compression Fracture

Osteoporotic compression fractures are common. It is estimated that up to 50% of women and 25% 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. A minority of patients will exhibit chronic pain following osteoporotic compression fracture that presents challenges for medical management.

Treatment
Chronic symptoms do not tend to respond to the management strategies for acute pain such as bedrest, immobilization or bracing device, and analgesic medication, sometimes including narcotic analgesics. The source of chronic pain after vertebral compression fracture may not be from the vertebra itself but may be predominantly related to strain on muscles and ligaments secondary to kyphosis. This type of pain frequently is not improved with analgesics and may be better addressed through exercise. Conventional vertebroplasty surgical intervention may be required in severe cases not responsive to conservative measures.

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

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

Regulatory Status
Kyphoplasty is a surgical procedure and, as such, is not subject to regulation by the United States (U.S.) Food and Drug Administration (FDA). Polymethylmethacrylate bone cement was available as a drug product before enactment of the FDA's device regulation and was at first considered what FDA termed a "transitional device." It was transitioned to a class III device and then to a class II device, which required future 510(k) submissions to meet "special controls" instead of "general controls" to assure safety and effectiveness. In July 2004, KyphX® HV-RTM bone cement was cleared for marketing by the FDA through the 510(k) process for the treatment of pathologic fractures of the vertebral body due to osteoporosis, cancer, or benign lesions using a balloon kyphoplasty procedure. Subsequently, other products such as Spine-Fix® Biomimetic Bone Cement, KYPHON® HV-R® Bone Cement, and Osteopal® V (Heraeus) have received 510(k) marketing clearance for the fixation of pathologic fractures of the vertebral body using vertebroplasty or kyphoplasty procedures.

Balloon kyphoplasty requires the use of an inflatable bone tamp. In July 1998, one such tamp, the KyphX® inflatable bone tamp, was cleared for marketing by the FDA through the 510(k) process. Additional devices for balloon kyphoplasty are listed in Table 1.

There are several mechanical vertebral augmentation devices that have received marketing clearance by the FDA through the 510(k) process; these are listed in Table 1.

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

FDA product code NDN.

Table 1. Kyphoplasty and Vertebral Augmentation Devices Cleared by the U.S. Food and Drug Administration

Device	Manufacturer	Date Cleared	510(k) Number	Indication
Balloon Kyphoplasty				
TRACKER Plus Kyphoplasty System	GS Medical Co., Ltd	10/28/2021	K211797	Reduction of fractures and/or creation of a void
Joline Kyphoplasty System Allevo	Joline GmbH & Co.	5/27/2020	K192449	To repair vertebral compression fractures
TRACKER Kyphoplasty System	GS Medical Co., Ltd	12/4/2019	K192335	Reduction of fractures or creation of a void
Stryker iVAS Elite Inflatable Vertebral Augmentation System (Stryker iVAS Elite Balloon Catheter)	Stryker Corporation	12/21/2018	K181752	To repair vertebral compression fractures
SpineKure Kyphoplasty System	Hanchang Co. Ltd.	05/29/2018	K172871	To repair vertebral compression fractures
Modified Winch Kyphoplasty (15 and 20 mm) 11 Gauge Balloon Catheters	G-21 s.r.l.	08/23/2017	K172214	To repair vertebral compression fractures
13G InterV Kyphoplasty Catheter (Micro) and 11G InterV Kyphoplasty Catheter (Mini-Flex)	Pan Medical Ltd.	11/1/2016	K162453	To repair vertebral compression fractures
MEDINAUT Kyphoplasty System	Imedicom Co. Ltd.	07/29/2016	K153296	To repair vertebral compression fractures

AVAflex Vertebral Balloon System	Carefusion	11/24/2015	K151125	To repair vertebral compression fractures
Osseoflex SB Straight Balloon 10g/4ml Osseoflex SB Straight Balloon 10g/2ml	Osseon LLC	4/9/2015	K150607	To repair vertebral compression fractures
InterV Kyphoplasty Catheter (Balloon Length: 1015 and 20mm) InterV Kyphoplasty Catheter (Mini) (Balloon Length: 10 15 and 20mm)	Pan Medical Ltd.	3/6/2015	K150322	To repair vertebral compression fractures
GUARDIAN-SG Inflatable Bone Expander System	BM Korea Co. Ltd.	1/16/2015	K143006	To repair vertebral compression fractures
ZVPLASTY	Zavation LLC	09/12/2014	K141419	To repair vertebral compression fractures
Mechanical Vertebral Augmentation				
KIVA VCF TREATMENT SYSTEM	Benvenue Medical Inc.	8/14/2014	K141141	To repair vertebral compression fractures
SpineJack Expansion Kit	Vexim SA	08/30/2018	K181262	To repair vertebral compression fractures
V-Strut Vertebral Implant	Hyprevention SAS	3/5/2020	K191709	Treatment of vertebral fractures in the thoracic and lumbar spine

Rationale

This medical policy was created in March 2002 and has been updated regularly with searches of the PubMed database. The most recent literature update was performed through February 16, 2022.

Medical policies assess the clinical evidence to determine whether the use of technology improves the net health outcome. Broadly defined, health outcomes are the length of life, quality of life (QOL), 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, two domains are examined: the relevance, and quality and credibility. To be relevant, studies must represent one 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.

The natural history of pain and disability associated with these conditions vary. Also, pain and functional ability are subjective outcomes, susceptible to placebo effects. Nonspecific or placebo effects can be quite large for an invasive procedure such as kyphoplasty for which there is no blinding. (1, 2) The placebo effect may be on the order of 6 to 7 mm on a 100-mm scale, for invasive procedures, (1-4) and even larger effects (10%) have been observed in the sham-controlled vertebroplasty trials. (5, 6) Therefore, sham-controlled comparison studies are important to demonstrate the clinical effectiveness of kyphoplasty over and above any associated nonspecific or placebo effects. Adverse effects related to kyphoplasty are the primary harms to be considered. Principal safety concerns relate to the incidence and consequences of leakage of the injected polymethylmethacrylate (PMMA).

Osteoporotic Vertebral Compression Fractures

Clinical Context and Therapy Purpose

The purpose of balloon kyphoplasty or mechanical vertebral augmentation is to provide a treatment option that is an alternative to or an improvement on existing therapies in patients with osteoporotic vertebral compression fractures (OVCF).

The question addressed in this medical policy is: Does the use of balloon kyphoplasty or mechanical vertebral augmentation improve the net health outcome for individuals who have OVCF?

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

Populations

The relevant population of interest is individuals with OVCF.

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

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

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

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

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

Outcomes
The general outcomes of interest are symptoms, functional outcomes, QOL, hospitalizations, and treatment-related morbidity. Kyphoplasty may also restore lost vertebral body height and

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

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

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

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

The Agency for Healthcare Research and Quality (AHRQ) published a comparative effectiveness review on selected interventional treatments for acute and chronic pain in September 2021. (7) The review included 37 RCTs for 10 interventional procedures and conditions that evaluated pain, function, health status, QOL, medication use, and harm. Results of the review concluded that vertebroplasty (13 trials) was probably more effective at reducing pain and improving function in patients >65 years of age, but benefits were small (<1 point on a 10-point pain scale). Benefits of vertebroplasty appeared smaller in sham-controlled trials compared with trials involving usual care as a control and larger in trials involving patients with more acute symptoms. Vertebroplasty was also found to be probably not associated with an increased risk of incident vertebral fracture. Kyphoplasty (2 trials) was concluded to probably be more effective than usual care for pain and function in older patients with vertebral compression fracture at up to 1 month and may be more effective at >1 month to ≥1 year but has not been compared against sham therapy. The evidence regarding the risk of incident fracture with kyphoplasty was conflicting. The overall evidence base for vertebroplasty had several limitations including variations in patient selection criteria, technical factors such as volume of PMMA, and sham interventions. Usual care interventions were also not well standardized or defined and the majority of results were based on mean differences in outcomes. Few trials reported the likelihood of achieving a clinically relevant response and data on long-term outcomes were limited. For kyphoplasty, a major limitation is the absence of sham-controlled trials.

Kyphoplasty or Vertebroplasty versus Conservative Treatment

Meta-analysis

In a Bayesian network meta-analysis, Zhao et al. (2017) examined the efficacy and safety of vertebroplasty, kyphoplasty, and conservative treatment for the treatment of OVCF. (8) Sixteen

RCTs were identified (total n=2046 participants; vertebroplasty, 816; kyphoplasty, 478; conservative treatment, 752). Eleven of the RCTs compared vertebroplasty with conservative treatment; two RCTs compared kyphoplasty with conservative treatment, and three RCTs compared kyphoplasty with vertebroplasty. Each trial assessed at least one of the following: visual analog score (VAS), the Roland-Morris Disability Questionnaire (RMDQ), the European Quality of Life-5 Dimensions, and the observance of any new fractures. Network meta-analysis demonstrated that kyphoplasty was superior to conservative therapy as assessed by VAS (mean difference, 0.94; 95% CI, -0.40 to 2.39), European Quality of Life-5 Dimensions (mean difference -0.10; 95% CI, -0.17 to -0.01), and RMDQ (mean difference, 5.72; 95% CI, 1.05 to 10.60). Insufficient data were present to complete pairwise comparison of kyphoplasty with conservative treatment for some metrics. No significant differences were found between vertebroplasty and kyphoplasty for pain relief, daily function, and QOL. Kyphoplasty was associated with the lowest risk of new fractures, while vertebroplasty was the most effective treatment for pain relief. This policy was limited by significant heterogeneity across measured outcomes and length of follow-up in studies; the presence of performing and reporting bias in studies was also a concern.

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

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

Halvachizadeh et al. (2021) conducted a systematic review and meta-analysis comparing vertebroplasty, kyphoplasty, and nonoperative management in patients with osteoporotic vertebral compression fractures. (11) A total of 16 RCTs (N=2731 patients) were included with 11 trials comparing vertebroplasty to nonoperative management, 1 trial comparing kyphoplasty to nonoperative management, and 4 comparing kyphoplasty and vertebroplasty. Surgical intervention was associated with greater improvement of pain as compared to nonoperative management and was unrelated to the development of adjacent level fractures or quality of life. Of the trials comparing kyphoplasty and vertebroplasty, no significant differences in outcome measures were observed. Fourteen of the 16 trials provided some concern for bias, and the remaining 2 trials provided a high concern for bias. The authors noted the heterogeneity of the included studies as a limitation. Nonoperative management was not

standardized, and the majority of studies failed to provide evidence of osteoporosis despite indicating that the treated fractures were osteoporotic vertebral fractures. Tables 2, 3, and 4 present a comparison of studies included in the systematic reviews, review characteristics, and results, respectively.

Table 2. Comparison of Studies Included in Systematic Reviews & Meta-analyses

Study	Zhao (2017) (8)	Hinde (2020) (9)	Sun (2020) (10)	Halvachizadeh (2021) (11)
Chen (2013)	●	●	●	
Blasco (2012)	●		●	●
Boonen (2011)	●			
Farrokhi (2011)	●		●	●
Klazen (2010a)	●		●	●
Klazen (2010b)			●	
Rousing (2009)	●		●	●
Kallmes (2009)	●			●
Buchbinder (2009)	●		●	●
Voormolen (2006)	●			●
Liu (2009)	●			
Endres (2012)	●			
Dohm (2014)	●			●
Clark (2016)	●		●	●
Staples (2015)	●		●	
Yang (2015)	●			
Berenson (2011)	●			
Ong (2018)		●		
Edidin (2015)		●		
Edidin (2011)		●		
McCullough (2013)		●		
Lin (2017)		●		
Zampini (2010)		●		
Lange (2014)		●		
McDonald (2011)		●		
Lavelle (2008)		●		
Gerling (2011)		●		
Becker (2011)		●		

Levy (2012)		●		
Diamond (2016)		●		
Klezl (2012)		●		
Liu (2015)		●		
Bornemann (2012)			●	
Kroon (2013)			●	
Diamond (2003)			●	
Firanescu (2018)			●	●
Giannotti (2012)			●	
Grafe (2005)			●	
Kasperk (2010)			●	
Klazen (2010)			●	
Lee (2012)			●	
Rousing (2010)			●	
Voormolen (2007			●	
Wang (2016)			●	●
Wang (2010)			●	
Wardlaw (2009)			●	●
Boonen (2011)			●	
Van Meirhaeghe (2013)			●	
Yang (2016)			●	
Yi (2014)			●	
Martinez-Ferrer (2013)			●	
Kroon (2013)			●	
Diamond (2006)			●	
Kasperk (2005)			●	
Lee (2012)			●	
Chen (2014)			●	●
Du (2018)			●	
Firanescu (2019)			●	
Kroon (2014)			●	
Movrin (2012)			●	
Voormolen (2007)			●	
Evans (2016)				●

Korovessis (2013)				●
Liu (2010)				●

Table 3. Systematic Reviews & Meta-analysis Characteristics

Study	Dates	Trials	Participants	N (Range)	Design
Zhao (2017) (8)	2006-2016	16	Patients with osteoporotic vertebral compression fracture	2046 (34 to 381)	RCT
Hinde (2020) (9)	2010-2018	7	Patients with osteoporotic vertebral compression fracture	1,649,247 (40 to 378,988)	Retrospective and prospective
Sun (2020) (10)	2005-2019	32	Patients with osteoporotic vertebral compression fracture	945 (34 to 300)	Prospective and RCTs
Halvachizadeh (2021) (11)	2006-2019	16	Patients with osteoporotic vertebral compression fracture	2731 (34 to 381)	RCT

RCT: randomized controlled trial.

Table 4. Systematic Reviews & Meta-analysis Results

Study	VAS	EQ-5D	RMDQ	New Fractures	Mortality
Zhao (2017) (8)					
MD (95% CI) CT vs KP	0.94 (-0.40 to 2.39)	-0.10 (-0.17 to -0.01)	5.72 (1.05 to 10.60)	1.11 (0.46 to 2.86)	
MD (95% CI) KP vs Vertebroplasty	0.05 (-0.18 to 0.27)	-0.02 (-0.06 to 0.02)	-2.50 (-3.40 to -1.60)	1.29 (0.84 to 1.99)	
Hinde (2020) (9)					
HR (95% CI) VA vs. CT					0.78 (0.66 to 0.92)
HR (95% CI) Balloon KP vs. Vertebroplasty					0.77 (0.77 to 0.78)
Sun (2020) (10)					

RR (95% CI) VA vs. CT				Clinical fracture: 1.22 (0.70 to 2.12) Radiological fracture: 0.91 (0.71 to 2.12)	
Halvachizadeh (2021) (11)		**Adjacent level fractures**			
VAS change: short-term; long-term (95% CI) Vertebroplasty or KP vs. CT	1.31 (0.41 to 2.21); 0.89 (0.16 to 1.62)				
p value	<.0001; <.0001				
I^2	99.8%; 99.2%				
VAS change: short-term; long-term (95% CI) KP vs. Vertebroplasty	-0.20 (-0.34 to -0.05); -0.30 (-0.98 to 0.37)				
p value	.90; .02				
I^2	0%; 81.9%				
Log OR (95% CI) Vertebroplasty or KP vs. CT		-0.16 (-0.83 to 0.50)			
MD (95% CI) Vertebroplasty or KP vs. CT			1.7 (0.01 to 3.47)		

CI: confidence interval; CT: conservative therapy; EQ-5D; European Quality of Life-5 Dimensions; HR: hazard ratio; OR: odds ratio; RR: relative risk; VA: vertebral augmentation; RMDQ: Roland-Morris Disability Questionnaire; KP: kyphoplasty; MD: mean difference; VAS: visual analog score.

Observational Studies

Edidin et al. (2011) reported on mortality risk in Medicare patients who had vertebral compression fractures (VCFs) and had been treated with vertebroplasty, kyphoplasty, or nonoperatively. (12) Using the U.S. Medicare dataset, the authors identified 858,978 patients who had VCFs between 2005 and 2008. The data set included 119,253 kyphoplasty patients and 63,693 vertebroplasty patients. Survival was calculated from the index diagnosis date until death or the end of follow-up (up to 4 years). Cox regression analysis was used to evaluate the

joint effect of multiple covariates, which included sex, age, race/ethnicity, patient health status, type of diagnosed fracture, site of service, physician specialty, socioeconomic status, year of diagnosis, and census region. After adjusting for covariates, patients in the surgical cohorts (vertebroplasty or kyphoplasty) had a higher adjusted survival rate (60.8%) than patients in the nonsurgical cohort (50.0%) and were 37% less likely to die. The adjusted survival rates for vertebroplasty or kyphoplasty were 57.3% and 62.8%, respectively, a 23% lower relative risk for kyphoplasty. As noted by the authors, a causal relation could not be determined from this study.

An industry-sponsored analysis by Ong et al. (2018) evaluated the effect of the sham-controlled vertebroplasty trials on utilization of kyphoplasty/vertebroplasty, morbidity, and mortality in the Medicare population. (5, 6, 13) Using the complete inpatient/outpatient U.S. Medicare data set from 2005 to 2014, the investigators evaluated utilization of vertebral augmentation procedures in patients with osteoporotic vertebral compression fractures who were treated in the 5 year period before 2009 and those who were treated in the 5 years after the sham-controlled trials were published. Use of the 2 procedures peaked at 24% of the osteoporotic vertebral compression fracture population in 2007 - 2008, then declined to 14% of osteoporotic vertebral compression fracture patients in 2014. Compared to patients with osteoporotic vertebral compression fractures treated non-surgically, the kyphoplasty cohort (n=261,756) had a 19% (95% CI 19-19%) lower propensity-adjusted 10 year mortality risk. Compared to patients with osteoporotic vertebral compression fracture treated with vertebroplasty (n=117,232), the kyphoplasty cohort had a 13% (95% CI, 12-13%) lower propensity-adjusted 10 year mortality risk. The study also found that patients treated with non-surgical management were more likely to be discharged to nursing facilities. Although the analysis did adjust for possible confounding factors, the observational nature of the study precludes any inference of causality.

Balloon Kyphoplasty vs Conservative Care

The largest trial of kyphoplasty vs conservative care is by Wardlaw et al. (2009), who reported on the Fracture Reduction Evaluation (FREE) trial, a nonblinded industry-sponsored, multisite RCT in which 300 adults with 1 to 3 painful OVCFs of less than 3 months in duration. (14) Twenty-four-month results were reported by Boonen et al. (2011) and by Van Meirhaeghe et al. (2013). (15, 16) Scores for the primary outcome, 1-month change in 36-Item Short-Form Health Survey (SF-36) Physical Component Summary (PCS) score, were significantly higher for those in the kyphoplasty group. The difference between groups was 5.2 points (95% confidence interval, 2.9 to 7.4 points; $p<0.001$). Kyphoplasty was associated with greater improvements in SF-36 PCS scores at 6-month follow-up (3.39 points), but not at 12- or 24-month follow-ups. Greater improvement in back pain was observed over 24 months for kyphoplasty (-1.49 points) and remained statistically significant at 24 months. Participants in the kyphoplasty group also reported greater improvements in quality of life and Roland-Morris Disability Questionnaire (RMDQ) scores at short-term follow-up. At 12 months, fewer kyphoplasty patients (26.4% vs 42.1%) had received physical therapy or walking aids, back braces, wheelchairs, miscellaneous aids, or other therapy. Fewer kyphoplasty patients used opioid medications through 6 months (29.8% vs 42.9%) and fewer pain medications through 12 months (51.7% vs. 68.3%). Other differences between groups were no longer apparent at 12 months, possibly due to natural

healing of fractures. Tables 5 and 6 summarize the key characteristics and results of the FREE trial. Tables 7 and 8 detail the relevance and design/conduct limitations of the study.

Table 5. Summary of Key RCT Characteristics

Study	Countries	Sites	Dates	Participants	Interventions	
					Active	**Comparator**
Wardlaw (2009), Boonen (2011), Van Meirheghe (2013) (14-16)	EU	21	2003-2005	Patients with 1-3 vertebral fractures	Balloon kyphoplasty (n=149)	Non-surgical care (n=151)

EU: European Union; RCT: randomized controlled trial; n: number.

Table 6. Summary of Key RCT Results

Study	Mean SF 36 PCS Score Improvement at 1 mo. (95% CI)	Difference in SF 36 Scores between Groups at 24 mo. (95% CI)	Serious Adverse Events within 30 days	Serious Adverse Events within 12 mo.	Serious Adverse Events within 24 mo.
Wardlaw (2009), Boonen (2011), Van Meirheghe (2013) (14-16)					
Kyphoplasty	7.2 (5.7 to 8.8)		24 (16.1%)	58 (38.9%)	74 (49.7%)
Control	2 (0.4 to 3.6)		17 (11.3%)	54 (35.8%)	73 (48.3%)
MD		3.24 (1.47 to 5.01)			
p value	<0.0001	0.0004			

CI: confidence interval; MD: man difference; mo: month; RCT: randomized controlled trial; SF-36 PCS: 36-Item Short-Form Physical Component Score.

Table 7. Study Relevance Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow-Up[e]
Wardlaw (2009), Boonen (2011), Van Meirheghe (2013) (14-16)			3. Non-surgical treatment was not standardized		2. 24 mo. follow-up

The study limitations stated in this table are those notable in the current literature 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 8. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Follow-Up[d]	Power[e]	Statistical[f]
Wardlaw (2009), Boonen (2011), Van Meirheghe (2013) (14-16)	3. Allocation concealment unclear	1, 2. Not blinded				

The study limitations stated in this table are those notable in the current literature 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.

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

Vertebral augmentation with the Kiva VCF System was compared with balloon kyphoplasty in a pivotal noninferiority RCT reported by Tuttonn et al. (2015). (17) This industry-sponsored, multicenter open-label (KAST) trial was conducted in 300 patients with 1 or 2 osteoporotic VCFs. Included were patients with VAS scores for back pain of at least 70 mm (/100 mm) after 2 to 6 weeks of conservative care or VAS scores of at least 50 mm after 6 weeks of conservative care, and Oswestry Disability Index (ODI) scores of at least 30%. The primary composite end point at 12 months was a reduction in fracture pain by at least 15 mm on the VAS, maintenance or improvement in function on the ODI, and absence of device-related serious adverse events.

The primary end point was met by 94.5% of patients treated with Kiva and 97.6% of patients treated with kyphoplasty (Bayesian posterior probability of 99.92% for noninferiority, using as-treated analysis). In the 285 treated patients, Kiva resulted in a mean improvement of 70.8 points in VAS scores, compared with a 71.8-point improvement for kyphoplasty. There was a 38.1-point improvement in ODI score for the Kiva group compared with a 42.2-point improvement for the kyphoplasty group. There were no device-related serious adverse events. The total volume of cement was 50% less with Kiva and there was less cement extravasion (16.9%) compared with kyphoplasty (25.8%).

Korovessis et al. (2013) reported a randomized trial of 180 patients with osteoporotic vertebral compression fractures that compared mechanical vertebral augmentation with the Kiva device with balloon kyphoplasty in 180 patients with osteoporotic vertebral compression fractures. (18) The groups showed similar improvements in VAS scores for back pain, SF-36 scores, and ODI scores. For example, there was a more than 5.5-point improvement in VAS scores in 54% of patients in the Kiva group and in 43% of patients in the balloon kyphoplasty group. Radiologic measures of vertebral height were similar in both groups. Kiva reduced the Gardner kyphotic angle, while residual kyphosis of more than 5° was more frequently observed in the balloon kyphoplasty group. Patients and outcome assessors were reported to be unaware of group assignments, although it is not clear if the Kiva device was visible on radiographs. Cement leakage into the canal only occurred in 2 patients treated with balloon kyphoplasty, necessitating decompression, compared with none following the Kiva procedure.

Noriega et al. (2019) reported the pivotal multicenter non-inferiority trial of the SpineJack vertebral augmentation system. (19) Patients (n=152) with osteoporotic vertebral compression fractures less than 3 months old were randomized to treatment with SpineJack or balloon kyphoplasty. The primary outcome was a composite measure that included improvement in visual analog scale for pain of greater than 20 mm, maintenance or improvement in Oswestry Disability Index, and lack of adverse events. Vertebral height was prespecified to be included if the primary outcome was achieved. Non-inferiority was achieved with 89.8% of SpineJack patients achieving the composite of clinical success compared to 87.3% for balloon kyphoplasty (see Table 9). When including the restoration of vertebral body height, the SpineJack procedure was found to be superior to balloon kyphoplasty at 6 months (88.1% vs. 60.9%) and at 12 months (79.7% vs. 59.3%, $p<0.001$). There was also a reduction in adjacent vertebral fractures with the mechanical augmentation system (12.9% vs. 27.3%; $p=0.043$). Interpretation of this study is limited by the lack of a sham control group.

Table 9. Summary of Key RCT Characteristics

Study	Countries	Sites	Dates	Participants	Interventions	
					Active	**Comparator**
Tutton et al. (2015) (17)	US, EU	21	2010-2013	Patients with OVCF	Kiva (n=153)	BK (n=147)

Korovessis et al. (2013) (18)	Greece	1	2010-2011	Patients with OVCF	Kiva (n=82 patients, 133 fractures)	BK (n=86 patients, 122 fractures)
Noriega et al. (2019) (19)	EU	13	2015-2017	Patients with OVCF aged <3 mo and loss of height ≥15% but ≤40%, VAS ≥ 50 mm and ODI ≥30%	SpineJack (n=77, 68 in mITT)	BK (n=75, 73 in mITT)

BK: balloon kyphoplasty; EU: European Union; mITT; modified intention-to-treat; n: number; ODI: Oswestry Disability Index; US: United States; OVCF: osteoporotic vertebral compression fracture; RCT: randomized controlled trial; VAS: visual analog score.

Table 10. Summary of Key RCT Results

Study	**Improvement in VAS Score at 12 mo.**	**Improvement in ODI at 12 mo.**		**Restoration of VBH**	**Percent Success**
				Anterior	**VAS Improvement of 5.5 Points**
Tutton et al. (2015) (17)					
Kiva	70.8	38.1			
BK	71.8	42.2			
Korovessis et al. (2013) (18)					
Kiva				24%	44 (54%)
BK				23%	37 (43%)
P value				0.97	
	Improvement in VAS at 1 mo ± SD	**Improvement in ODI at 1 mo ± SD**	**Improvement in EQ-5D at 1 mo ± SD**	**Midline ± SD**	**Percent Achieving CCS (95% CI)**
Noriega et al. (2019) (19)					
Spine-Jack	56.4 ± 20.3	44.2 ± 21.2	0.45 ± 0.29	1.31 ± 2.58	89.8% (82.1%–97.5%)
BK	47.8 ± 25.7	39.9 ± 23.7	0.42 ± 0.29	0.10 ± 2.34	87.3% (78.5%–96.1%)
p-Value	0.029	0.321	0.598	0.0035	0.0016

BK: balloon kyphoplasty; CCS: composite clinical success; CI: confidence interval; EQ-5D: EuroQol 5-domain questionnaire; mo: month(s); ODI: Oswestry Disability Index; RCT: randomized controlled trial; SD: standard deviation; VAS: visual analog scale; VBH: vertebral

body height.
Composite clinical success included greater than 20 mm improvement in visual analog score, maintenance or improvement in ODI, and absence of adverse events.

Table 11. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective Reporting[c]	Follow-Up[d]	Power[e]	Statistical[f]
Tutton (2015) (17)	2. Allocation not concealed throughout study	1, 2. Patients only blinded prior to procedure performance			2. Study not powered for primary or secondary endpoint	
Korovessis (2013) (18)		1, 2. Not blinded				
Noriega et al. (2019) (19)		1. Not blinded for patient-reported outcomes. Radiographic assessments were blinded				

The study limitations stated in this table are those notable in the current literature 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: Osteoporotic Vertebral Compression Fractures
An AHRQ review concluded that vertebroplasty was probably more effective at reducing pain and improving function in patients >65 years of age, but benefits were small (<1 point on a 10-point pain scale). Kyphoplasty was found to be probably more effective than usual care for pain

and function in older patients with vertebral compression fracture at up to 1 month and may be more effective at >1 month to ≥1 year but has not been compared against sham therapy. The review found that the overall evidence base for vertebroplasty had several limitations while the absence of sham-controlled trials is a major limitation for kyphoplasty.

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

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

Osteolytic Vertebral Compression Fractures

Clinical Context and Therapy Purpose

The purpose of balloon kyphoplasty or mechanical vertebral augmentation is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as conservative care, in patients with osteolytic vertebral compression fractures.

The question addressed in this medical policy is: Does the use of balloon kyphoplasty or mechanical vertebral augmentation improve the net health outcome for individuals who have OVCF or osteolytic vertebral compression fractures (VCF)?

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

Populations

The relevant population of interest is individuals with osteolytic VCF.

Interventions

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

Comparators
Comparators of interest include conservative care. Treatment includes bed rest, local and systemic analgesia, and bracing.

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

Table 12. Outcomes of Interest for Individuals with OVCFs

Outcomes	Details
Quality of Life	Reduced pain, disability, and analgesic use in patients

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

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

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

Systematic Reviews
In a systematic review, Health Quality Ontario (2016) assessed vertebral augmentation for cancer related VCFs. (20) The assessment identified 33 reports with 1,690 patients who were treated with kyphoplasty for spinal metastatic cancers, multiple myeloma, or hemangiomas. For cancer-related VCFs there were 5 case series (110 patients) on multiple myeloma and 6 reports (2 RCTs, 4 case series; 308 patients) on mixed cancers with spinal metastases. Vertebral augmentation resulted in reductions in pain intensity scores, opioid or other analgesic use, and disability scores. One RCT (n=129) compared kyphoplasty with nonsurgical management for cancer-related VCFs, reporting that pain scores, pain related disability, and health-related quality of life were significantly improved in the kyphoplasty group than in the usual care group. The second RCT compared the Kiva device with kyphoplasty in 47 patients with cancer-related compression fractures, finding no significant differences between groups for improvements in VAS pain and ODI scores.

Mattie et al. (2021) conducted a systematic review and meta-analysis of 7 RCTs (N=476) that compared the magnitude and duration of pain relief with vertebral augmentation (i.e., balloon kyphoplasty or percutaneous vertebroplasty), with or without additional therapy, to any other intervention or placebo/sham for the treatment of cancer-related vertebral compression fractures. (21) In 5 of the 7 studies, vertebral augmentation alone comprised 1 group; comparative treatments included nonsurgical management, Kiva implantation, and combinations of percutaneous vertebroplasty and radiofrequency therapy, chemotherapy, instrasomatic steroid injection, or ^{125}I seeds. Results revealed an overall positive and statistically significant effect of vertebral augmentation for the management of cancer-related vertebral compression fractures. This effect was particularly pronounced when comparing vertebral augmentation to nonsurgical management, radiofrequency ablation, or chemotherapy alone. The authors noted that there was much heterogeneity among the included studies regarding the treatment methods in the control groups and 1 study allowed patients to crossover to the intervention group, potentially leading to biased results.

Randomized Controlled Trials

The only RCT to compare kyphoplasty to non-surgical management was an international multicenter study reported by Berenson et al. (2011). (22) The trial enrolled 134 patients with cancer who were at least 21 years of age. Participants had at least 1 and not more than 3 painful VCFs. The primary outcome was change in functional status from baseline at 1 month as measured by the RMDQ. Treatment allocation was not blinded, and the primary outcome at 1 month was analyzed using all participants with data both at baseline and at 1 month. Participants needed to have a pain score of at least 4 on a 0-to-10 scale. Crossover to the balloon kyphoplasty arm was allowed after 1 month. Reviewers reported scores for the kyphoplasty and nonsurgical groups of 17.6 and 18.2 at baseline, respectively, and 9.10 and 18.0 at 1-month follow-ups (between-group difference in scores, $p<0.001$).

Korovessis et al. (2014) compared efficacy of Kiva and kyphoplasty in an RCT with 47 participants with osteolytic vertebral compression fractures. (23) Oswestry Disability Index scores improved by 42 and 43 points in the kyphoplasty and Kiva groups, respectively. Pain scores improved by 5.1 points in both groups, from baseline mean scores of 8.1 (kyphoplasty) and 8.3 (Kiva).

Section Summary: Osteolytic VCF

Results of RCTs and case series suggest vertebral augmentation reduces pain, disability, and analgesic use in patients with cancer-related compression fractures. However, because the results of the comparative studies of vertebroplasty have also suggested possible placebo or natural history effects, the evidence provided is insufficient to warrant conclusions about the effect of kyphoplasty on health outcomes.

Radiofrequency Kyphoplasty

Clinical Context and Therapy Purpose

The purpose of RFK is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as conservative care, in patients with osteoporotic or osteolytic vertebral compression fractures.

The question addressed in this medical policy is: Does the use of RFK improve the net health outcome for individuals who have OVCF or osteolytic VCF?

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

Populations
The relevant population of interest is individuals with osteoporotic or osteolytic VCF.

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

Comparators
Comparators of interest include conservative care. Treatment includes bed rest, local and systemic analgesia, and bracing.

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

Table 13. Outcomes of Interest for Individuals with OVCFs

Outcomes	Details
Quality of Life	Reduced pain, disability, and analgesic use in patients

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

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

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

Systematic Reviews

Feng et al. (2017) performed a meta-analysis comparing RFK with balloon kyphoplasty in patients with VCFs. (24) Six studies (total n=833 patients) evaluating VCFs were identified. The main outcomes were pain relief (VAS), functionality improvement (ODI), operation time, reduction of deformity (i.e., the restoration of vertebral height and kyphosis angle), and incidence of cement leakage. VAS scores improved for both groups after the respective procedure; however, VAS score dropped 3.96 points more in the RFK group (95% CI, 1.67 to 6.24; p=0.001), with improvement persisting until the 12-month mark. While functionality improvement was initially improved more after RFK than balloon kyphoplasty (p=0.04), the difference between the two groups was not significant after a year (p=0.6). No significant difference in cement leakage between groups was observed. This review was limited by the small number of studies included as well as the presence of significant bias within these studies.

Randomized Controlled Trials

Petersen et al. (2016) reported on an RCT with 80 patients that compared RFK with balloon kyphoplasty. (25) Patients had been admitted to the hospital for severe back pain and met criteria for surgery after failed conservative treatment. All had osteoporotic compression fractures. Prior to treatment, VAS pain scores on movement were similar in both groups (8.4 in the balloon kyphoplasty group vs 8.0 in the RFK group). Postoperatively, VAS scores improved by 4.6 after balloon kyphoplasty and 4.4 after RFK (p=NS). Pain at 12 months also did not differ significantly between both groups, with 58% of patients in the balloon kyphoplasty group and 66% of patients in the RFK group reporting no to mild pain on movement (p=NS). There was a trend for greater restoration of the kyphosis angle.

Section Summary: RFK

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

Adverse Events

Yi et al. (2014) assessed the occurrence of new VCFs after treatment with cement augmenting procedures (vertebroplasty or kyphoplasty) vs conservative treatment in an RCT with 290 patients (363 affected vertebrae). (26) Surgically treated patients were discharged the next day. Patients treated conservatively (pain medication, bedrest, a body brace, physical therapy) had a mean length of stay of 13.7 days. Return to usual activity occurred at 1 week for 87.6% of surgically treated patients and at 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 VCFs. There was no significant difference in the incidence of new vertebral fractures between the operative (n=18; 9 adjacent, 9 nonadjacent) and conservative (n=24; 5 adjacent, 16 nonadjacent, 3 same

level) groups, but the mean time to a new fracture was significantly shorter in the surgical group (9.7 months) compared with the nonoperative group (22.4 months).

Summary of Evidence

For individuals who have osteoporotic vertebral compression fractures who receive balloon kyphoplasty, or mechanical vertebral augmentation, the evidence includes an Agency for Healthcare Research and Quality (AHRQ) comparative effectiveness review, randomized controlled trials (RCTs) and meta-analyses. Relevant outcomes include symptoms, functional outcomes, quality of life, hospitalizations, and treatment-related morbidity. The AHRQ review concluded that vertebroplasty was probably more effective at reducing pain and improving function in patients >65 years of age, but benefits were small. Kyphopasty was found to be probably more effective than usual care for pain and function in older patients with vertebral compression fracture at up to 1 month and may be more effective at >1 month to ≥1 year but has not been compared against sham therapy. A meta-analysis and moderately sized unblinded RCT have compared kyphoplasty with conservative care and found short-term benefits in pain and other outcomes. One systematic review of RCTs found no significant difference in subsequent fracture between vertebroplasty and conservative treatment, and another systematic review of prospective and retrospective studies reported improved mortality with either vertebroplasty or balloon kyphoplasty compared with conservative treatment. Other RCTs, summarized in a meta-analysis, have reported similar outcomes for kyphoplasty and vertebroplasty. Three randomized trials that compared mechanical vertebral augmentation (Kiva or SpineJack) with kyphoplasty have reported similar outcomes for both procedures. A major limitation of all these RCTs is the lack of a sham procedure. Due to the possible sham effect observed in the recent trials of vertebroplasty, the validity of the results from non-sham-controlled trials is unclear. Therefore, whether these improvements represent a true treatment effect is uncertain. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

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

For individuals who have osteoporotic or osteolytic vertebral compression fractures who receive radiofrequency kyphoplasty, the evidence includes a systematic review and a RCT. Relevant outcomes include symptoms, functional outcomes, quality of life, hospitalizations, and

treatment-related morbidity. The only RCT (N=80) identified showed similar results between radiofrequency kyphoplasty and balloon kyphoplasty. The systematic review suggested that radiofrequency kyphoplasty is superior to balloon kyphoplasty in pain relief, but the review itself was limited by the inclusion of a small number of studies as well as possible bias. Corroboration of these results in a larger number of patients is needed to determine with greater certainty whether radiofrequency kyphoplasty has outcomes similar to balloon kyphoplasty. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

Practice Guidelines and Position Statements

American College of Radiology, et al.

The American College of Radiology (2014) and 7 other surgical and radiologic specialty associations published a joint position statement on percutaneous vertebral augmentation. (27) This document stated that percutaneous vertebral augmentation, using vertebroplasty or kyphoplasty and performed in a manner consistent with public standards, is a safe, efficacious, and durable procedure in appropriate patients with symptomatic osteoporotic and neoplastic fractures. The statement also indicated that these procedures be offered only when nonoperative medical therapy has not provided adequate pain relief or pain is significantly altering the patient's quality of life.

A joint practice parameter for the performance of vertebral augmentation was updated in 2017. (28)

Society of Interventional Radiology

In a quality improvement guideline on percutaneous vertebroplasty from the Society of Interventional Radiology (2014), vertebral augmentation was recommended for compression fractures refractory to medical therapy. (27) Failure of medical therapy includes the following situations:

1. Patients who are "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. Patients 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. Patients with "a weakened or fractured vertebral body, and 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

The American Academy of Orthopaedic Surgeons (2010) approved clinical guidelines on the treatment of osteoporotic spinal compression fractures, which had a weak recommendation for offering kyphoplasty to patients who "present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically intact." (29) The Academy indicated that future evidence could overturn existing evidence and that the

quality of the current literature is poor. These recommendations were based on literature reviewed through September 2009.

National Institute for Health and Care Excellence

The National Institute for Health and Care Excellence (2013) issued a guidance that recommended percutaneous vertebroplasty and percutaneous balloon kyphoplasty as treatment 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 through physical exam and imaging at the level of the fracture. (30) This guidance did not address balloon kyphoplasty with stenting, because the manufacturer of the stenting system (Synthes) stated there is limited evidence for vertebral body stenting given that the system had only recently become available.

The Institute (2008) issued guidance on the diagnosis and management of adults with metastatic spinal cord compression. It was last reviewed in 2014 and placed on the static list (no major ongoing studies identified, with the next review in 5 years). (31) The guidance stated that vertebroplasty or kyphoplasty should be considered for patients who have vertebral metastases, and no evidence of spinal cord compression or spinal instability, if they have mechanical pain resistant to conventional pain management and vertebral body collapse. Surgery should only be performed when all appropriate specialists, agree. Despite a relatively small sample base, the Institute concluded the evidence suggests, in a select subset of patients, that early surgery may be more effective at maintaining mobility than radiotherapy.

Ongoing and Unpublished Clinical Trials

Some currently unpublished trials that might influence this policy are listed in Table 14.

Table 14. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Unpublished			
NCT03730207[a]	A Prospective, 1: 1 Randomized, Single Blind, Multi-center Human Clinical Trial	180	Oct 2021
NCT02700308	A Randomized, Multicenter, Open-label, Bayesian-based Phase II Study of the Feasibility of Kyphoplasty in the Local Treatment of Spine Metastases From Solid Tumors	31	Jul 2022 (terminated)
NCT04581707	Evaluation of Surgical Therapy of Vertebral Compression Fractures With the Kyphoplasty Single Balloon Catheter Allevo (Joline®) and the Quattroplasty Double Balloon Catheter Stop'n GO (Joline®) With BonOs® Inject Bone Cement	80	Oct 2021

NCT: national clinical trial.
[a] Denotes industry-sponsored or cosponsored trial.

Coding

Procedure codes on Medical Policy documents are included **only** as a general reference tool for each policy. **They may not be all-inclusive.**

The presence or absence of procedure, service, supply, or device codes in a Medical Policy document has no relevance for determination of benefit coverage for members or reimbursement for providers. **Only the written coverage position in a Medical Policy should be used for such determinations.**

Benefit coverage determinations based on written Medical Policy coverage positions must include review of the member's benefit contract or Summary Plan Description (SPD) for defined coverage vs. non-coverage, benefit exclusions, and benefit limitations such as dollar or duration caps.

CPT Codes	22513, 22514, 22515
HCPCS Codes	C1062, C7507, C7508

*Current Procedural Terminology (CPT®) ©2022 American Medical Association: Chicago, IL.

References

1. Jarvik JG, Deyo RA. Cementing the evidence: time for a randomized trial of vertebroplasty. AJNR Am J Neuroradiol. Sep 2000; 21(8):1373-1374. PMID 11003266
2. Moerman DE, Jonas WB. Deconstructing the placebo effect and finding the meaning response. Ann Intern Med. Mar 19 2002; 136(6):471-476. PMID 11900500
3. Hrobjartsson A, Gotzsche PC. Is the placebo powerless? An analysis of clinical trials comparing placebo with no treatment. N Engl J Med. May 24 2001; 344(21):1594-1602. PMID 11372012
4. Vase L, Riley JL, 3rd, Price DD. A comparison of placebo effects in clinical analgesic trials versus studies of placebo analgesia. Pain. Oct 2002; 99(3):443-452. PMID 12406519
5. 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):557-568. PMID 19657121
6. 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):569-579. PMID 19657122
7. Chou R, Fu R, Dana T, et al. Interventional treatments for acute and chronic pain: systematic review [Internet]. AHRQ Comparative Effectiveness Reviews. Rockville (MD): Agency for Healthcare Research and Quality; Sep 2021. Report No.:21-EHC030.
8. Zhao S, Xu CY, Zhu AR, et al. Comparison of the efficacy and safety of 3 treatments for patients with osteoporotic vertebral compression fractures: A network meta-analysis. Medicine (Baltimore). Jun 2017; 96(26):e7328. PMID 28658144
9. 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

10. Sun HB, Jing XS, Tang H, et al. Clinical and radiological subsequent fractures after vertebral augmentation for treating osteoporotic vertebral compression fractures: a meta-analysis. Eur Spine J. Oct 2020; 29(10):2576-2590. PMID 32776263
11. Halvachizadeh S, Stalder AL, Bellut D, et al. Systematic Review and meta-analysis of 3 treatment arms for vertebral compression fractures: a comparison of improvement in pain, adjacent-level fractures, and quality of life between vertebroplasty, kyphoplasty, and nonoperative management. JBJS Rev. Oct 25 2021; 9(10). PMID 34695056
12. 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):1617-1626. PMID 21308780
13. Ong KL, Beall DP, Frohbergh M et al. Were VCF patients at higher risk of mortality following the 2009 publication of the vertebroplasty "sham" trials? Osteoporos Int. Feb 2018; 29(2):375-383. PMID 29063215
14. Wardlaw D, Cummings SR, Van Meirhaeghe J, et al. Efficacy and safety of balloon kyphoplasty compared with non-surgical care for vertebral compression fracture (FREE): a randomised controlled trial. Lancet. Mar 21 2009; 373(9668):1016-1024. PMID 19246088
15. Boonen S, Van Meirhaeghe J, Bastian L, et al. Balloon kyphoplasty for the treatment of acute vertebral compression fractures: 2-year results from a randomized trial. J Bone Miner Res. Jul 2011; 26(7):1627-1637. PMID 21337428
16. Van Meirhaeghe J, Bastian L, Boonen S, et al. A randomized trial of balloon kyphoplasty and nonsurgical management for treating acute vertebral compression fractures: vertebral body kyphosis correction and surgical parameters. Spine (Phila Pa 1976). May 20 2013; 38(12):971-983. PMID 23446769
17. Tutton SM, Pflugmacher R, Davidian M, et al. KAST Study: The Kiva System as a vertebral augmentation treatment-a safety and effectiveness trial: a randomized, noninferiority trial comparing the Kiva System with balloon kyphoplasty in treatment of osteoporotic vertebral compression fractures. Spine (Phila Pa 1976). Jun 15 2015; 40(12):865-875. PMID 25822543
18. Korovessis P, Vardakastanis K, Repantis T, et al. Balloon kyphoplasty versus KIVA Vertebral augmentation comparison of 2 techniques for osteoporotic vertebral body fractures: a prospective randomized study. Spine (Phila Pa 1976). Feb 15 2013; 38(4):292-299. PMID 23407406
19. Noriega D, Marcia S, Theumann N et al. A prospective, international, randomized, noninferiority study comparing an implantable titanium vertebral augmentation device versus balloon kyphoplasty in the reduction of vertebral compression fractures (SAKOS study). Spine J. Nov 2019; 19(11):1782-1795. PMID 31325625
20. Pron G, Holubowich C, Kaulback K. Vertebral augmentation involving vertebroplasty or kyphoplasty for cancer-related vertebral compression fractures: a systematic review. Ont Health Technol Assess Ser. 2016; 16(11):1-202. PMID 27298655
21. Mattie R, Brar N, Tram JT, et al. Vertebral augmentation of cancer-related spinal compression fractures: a systematic review and meta-analysis. Spine (Phila Pa 1976). Dec 15 2021; 46(24):1729-1737. PMID 33958537
22. Berenson J, Pflugmacher R, Jarzem P, et al. Balloon kyphoplasty versus non-surgical fracture management for treatment of painful vertebral body compression fractures in patients with

cancer: a multicentre, randomized controlled trial. Lancet Oncol. Mar 2011; 12(3):225-235. PMID 21333599
23. Korovessis P, Vardakastanis K, Vitsas V et al. Is Kiva implant advantageous to balloon kyphoplasty in treating osteolytic metastasis to the spine? Comparison of 2 percutaneous minimal invasive spine techniques: a prospective randomized controlled short-term study. Spine. Feb 15 2014; 39(4):E231-E239. PMID 24253785
24. Feng L, Shen JM, Feng C, et al. Comparison of radiofrequency kyphoplasty (RFK) and balloon kyphoplasty (BKP) in the treatment of vertebral compression fractures: A meta-analysis. Medicine (Baltimore). Jun 2017; 96(25):e7150. PMID 28640091
25. Petersen A, Hartwig E, Koch EM, et al. Clinical comparison of postoperative results of balloon kyphoplasty (BKP) versus radiofrequency-targeted vertebral augmentation (RF-TVA): a prospective clinical study. Eur J Orthop Surg Traumatol. Jan 2016; 26(1):67-75. PMID 26482590
26. 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
27. Baerlocher MO, Saad WE, Dariushnia S, et al. Quality improvement guidelines for percutaneous vertebroplasty. J Vasc Interv Radiol. Feb 2014; 25(2):165-170. PMID 24238815
28. ACR-ASNR-ASSR-SIR-SNIS Practice Parameter for the Performance of Vertebral Augmentation. Available at <https://www.acr.org> (accessed February 16, 2022).
29. American Academy of Orthopaedic Surgeons (AAOS). The treatment of symptomatic osteoporotic spinal compression fractures: summary of recommendations. 2010. Available at <http://www.mainegeneral.org> (accessed February 16, 2022).
30. National Institute for Health and Care Excellence (NICE). Percutaneous vertebroplasty and percutaneous balloon kyphoplasty for treating osteoporotic vertebral compression fractures [TA279] (2013). Available at <https://www.nice.org.uk> (accessed February 16, 2022).
31. National Institute for Health and Care Excellence (NICE). Metastatic spinal cord compression in adults: risk assessment, diagnosis and management [CG75] (2008). Available at <https://www.nice.org.uk> (accessed February 16, 2022).

Centers for Medicare and Medicaid Services (CMS)

The information contained in this section is for informational purposes only. HCSC makes no representation as to the accuracy of this information. It is not to be used for claims adjudication for HCSC Plans.

The Centers for Medicare and Medicaid Services (CMS) **does not** have a national Medicare coverage position. Coverage may be subject to local carrier discretion.

A national coverage position for Medicare may have been **developed** since this medical policy document was written. See Medicare's National Coverage at <http://www.cms.hhs.gov>.

Policy History/Revision

Date	Description of Change

02/01/2024	Reviewed. No changes.
06/01/2023	Document updated with literature review. The following change was made to Coverage: Modified conditional coverage criteria for percutaneous balloon kyphoplasty or mechanical vertebral augmentation. Added the following references: 7, 9-11, and 21.
09/15/2021	Reviewed. No changes.
01/01/2021	Document updated with literature review. The following changes were made to Coverage: 1) Clarified that the medically necessary statements on compression fractures apply to the thoracolumbar spine; and 2) Removed tradename "Kiva" to describe mechanical vertebral augmentation and replaced with "with an FDA cleared device". Added/updated the following references: 15, 21, 24, 29 and 32.
11/15/2019	Document updated with literature review. The following change was made to Coverage: Added "Symptomatic osteoporotic vertebral compression fractures that are less than 6 weeks in duration that have led to hospitalization or persist at a level that prevents ambulation" as a conditional criterion for percutaneous balloon kyphoplasty or mechanical vertebral augmentation (i.e., with Kiva®). The following references were added: 19-20, 23 and 30.
06/01/2018	Document updated with literature review. The following changes were made to Coverage. 1) added "compression" to state "The treatment of symptomatic osteoporotic vertebral compression fractures that have failed to respond to conservative treatment (e.g., analgesics, physical therapy, rest) for at least 6 weeks" 2) Editorial change" for immediate" changed to "including" in the experimental, investigational and/or unproven coverage statement. 3) Added "Radiofrequency" and maintained language "including but not limited to vertebral body stenting" to the experimental, investigational and/or unproven coverage statement for devices. Title changed from Percutaneous Balloon Kyphoplasty and Mechanical Vertebral Augmentation.
12/01/2016	Reviewed. No changes.
02/01/2016	Document updated with literature review. 1) mechanical vertebral augmentation with Kiva was changed to medically necessary for a) the treatment of symptomatic osteoporotic vertebral fractures that have failed to respond to conservative treatment (e.g., analgesics, physical therapy, rest) for at least 6 weeks; and b) for the treatment of severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies. 2) Percutaneous balloon kyphoplasty and mechanical vertebral augmentation with Kiva® is considered experimental, investigational, and/or unproven for immediate use in acute vertebral fractures due to osteoporosis or trauma. 3)Percutaneous balloon kyphoplasty and mechanical vertebral augmentation with Kiva® is considered experimental, investigational, and/or unproven for all other indications.4) Percutaneous mechanical vertebral

	augmentation using any other device, including but not limited to vertebral body stenting, is considered experimental, investigational, and/or unproven.
02/15/2015	Document updated with literature review. The following was added to Coverage: Percutaneous mechanical vertebral augmentation using any other device, including but not limited to Kiva® and vertebral body stenting, is considered experimental, investigational and/or unproven. In addition, "Percutaneous Vertebroplasty and Sacroplasty" were removed from this policy and are now on Medical Policy RAD601.056 Percutaneous Vertebroplasty and Sacroplasty. The title of this document changed from "Percutaneous Vertebroplasty, Percutaneous Kyphoplasty, and Percutaneous Sacroplasty."0
09/15/2012	Document updated with literature review. Title changed to include "Percutaneous Sacroplasty". The following change was made to coverage: Percutaneous sacroplasty is considered experimental, investigational and unproven for all indications, including use in sacral insufficiency fractures due to osteoporosis and spinal lesions due to metastatic malignancies or multiple myeloma.
09/01/2010	Document updated with literature review. Title changed from "Percutaneous Polymethylmethacrylate Vertebroplasty, Percutaneous Kyphoplasty". The following changes were made 1) Percutaneous Polymethylmethacrylate Vertebroplasty (PPV) or Percutaneous Kyphoplasty (PK) may be considered medically necessary for the treatment of symptomatic osteoporotic vertebral fractures that have failed to respond to conservative treatment, or for the treatment of severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies. 2) PPV and PK are considered experimental, investigational and unproven for all other indications. 3). Sacroplasty is considered experimental, investigational and unproven for all indications.
02/15/2008	Revised/Updated Entire Document
01/01/2007	Codes Revised/Added Deleted
02/01/2006	Revised/Updated Entire Document
01/01/2006	Codes Revised/Added Deleted
03/30/2004	Revised/Updated Entire Document
03/01/2002	New Medical Document