6.01.38	Percutaneous Balloon Kyphoplasty, Radiofrequency Kyphoplasty, and Mechanical Vertebral Augmentation		
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Policy Statement

Balloon kyphoplasty or mechanical vertebral augmentation using Kiva may be considered **medically necessary** for the treatment of **any** of the following indications:

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

Balloon kyphoplasty or mechanical vertebral augmentation using Kiva are considered **investigational** for all other indications, including use in acute vertebral fractures due to osteoporosis or trauma.

Radiofrequency kyphoplasty is considered **investigational**.

Mechanical vertebral augmentation using any other device is considered **investigational**.

Policy Guidelines

Based on currently available evidence, health outcomes for kyphoplasty, Kiva, and vertebroplasty appear to be equivalent, therefore, the "least costly alternative" provision of the **medically necessary** definition may apply. In accordance with Blue Shield of California's medical necessity criteria, if there are two or more **medically necessary** services that may be provided for an illness, injury or medical condition, Blue Shield of California will provide benefits based on the most cost-effective service. Treatment with mechanical vertebral augmentation with kyphoplasty or Kiva® is likely to produce equivalent outcomes compared with vertebroplasty but may be more costly. In these cases, when it is determined that a strategy using kyphoplasty or Kiva® is more costly than one using vertebroplasty, then kyphoplasty or Kiva® may be considered **not medically necessary**.

Coding

There are CPT codes that combine the kyphoplasty procedure with all of the necessary imaging guidance:

- **22513**: Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (e.g., kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging guidance; thoracic
- **22514**: Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (e.g., kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging guidance; lumbar
- **22515**: Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (e.g., kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging

guidance; each additional thoracic or lumbar vertebral body (List separately in addition to code for primary procedure)

Description

Percutaneous balloon kyphoplasty, radiofrequency kyphoplasty (RFK), and mechanical vertebral augmentation with Kiva are interventional techniques involving the fluoroscopically guided injection of polymethylmethacrylate 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 those with osteolytic lesions of the spine (i.e., multiple myeloma, metastatic malignancies).

Related Policies

- Percutaneous Vertebroplasty and Sacroplasty

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

Kyphoplasty is a surgical procedure and, as such, is not subject to regulation by the U.S. Food and Drug Administration (FDA). Balloon kyphoplasty requires the use of an inflatable bone tamp. In July 1998, one such tamp, the KyphX® inflatable bone tamp (Medtronic), was cleared for marketing by the FDA through the 510(k) process. Other devices with the FDA 510(k) marketing clearance include the AVA*max*® Vertebral Balloon system (CareFusion), NeuroTherm Parallax® Balloon Inflatable Bone Tamp (NeuroTherm), Stryker iVAS® Balloon catheter, and Synthes Synflate™ Vertebral Balloon System (Synthes [West Chester, PA]). StabiliT® Vertebral Augmentation System (Merit Medical) for radiofrequency vertebral augmentation was cleared for marketing in 2009. FDA product code NDN.

In 2014, the Kiva® VCF Treatment System (Benvenue Medical) was cleared for marketing by the FDA through the 510(k) process. FDA product code NDN.

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 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 issued 510(k) marketing clearance for the

fixation of pathologic fractures of the vertebral body using vertebroplasty or kyphoplasty procedures. FDA product code: NDN.

Table 1 lists examples of FDA-cleared devices for kyphoplasty and vertebral augmentation.

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

Device	Manufacturer	Date Cleared	510(k) No.	Indication
Stryker iVAS Elite Inflatable Vertebral Augmentation System (Stryker iVAS Elite Balloon Catheter)	Stryker Corporation	12/21/2018	K181752	To repair vertebral compression fractures
SpineJack Expansion Kit	Vexim SA	8/30/2018	K181262	To repair vertebral compression fractures
SpineKure Kyphoplasty System	Hanchang Co. Ltd.	5/29/2018	K172871	To repair vertebral compression fractures
KYPHON HV-R Bone Cement	Medtronic Sofamor Danek USA Inc.	5/18/2018	K180700	To repair vertebral compression fractures
Modified Winch Kyphoplasty (15 and 20 mm) 11 Gauge Balloon Catheters	G-21 s.r.l.	8/23/2017	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
Kyphon HV-R Bone Cement	MEDTRONIC INC	8/24/2016	K160983	To repair vertebral compression fractures
MEDINAUT Kyphoplasty System	IMEDICOM Co. Ltd.	7/29/2016	K153296	To repair vertebral compression fractures
OSTEOPAL plus	HERAEUS MEDICAL GMBH	4/22/2016	K153737	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 KyphoplastyCatheter (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

Device	Manufacturer	Date Cleared	510(k) No.	Indication
ZVPLASTY	ZAVATION LLC	9/12/2014	K141419	To repair vertebral compression fractures
KIVA VCF TREATMENT SYSTEM	BENVENUE MEDICAL INC.	8/14/2014	K141141	To repair vertebral compression fractures

Rationale

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 one 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.

Literature Review

This review has been informed by a 2000 Blue Cross Blue Shield Association Technology Evaluation Center (TEC) Assessment,[1] updated with TEC Assessments in 2004,[1,] 2005,[2,] 2008,[3,] 2009,[4,] and 2010.[5,]

Evidence reviews 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.[6,7,] The placebo effect may be on the order of 6 to 7 mm on a 100-mm scale, for invasive procedures,[6,7,8,9,] and even larger effects (10%) have been observed in the sham-controlled vertebroplasty trials.[10,11,] 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 (Kiva) 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 evidence review is: does the use of balloon kyphoplasty or mechanical vertebral augmentation improve the net health outcome for individuals who have OVCF?

The following PICOTS were used to select literature to inform this review.

Patients
The relevant population of interest are individuals with OVCF.

Interventions
The therapy being considered is balloon kyphoplasty or mechanical vertebral augmentation (Kiva). 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.

It has been proposed that kyphoplasty may provide an analgesic effect through mechanical stabilization of a fractured or otherwise weakened vertebral body. However, other possible mechanisms of effect have been postulated, one of which is thermal damage to intraosseous

nerve fibers, given that PMMA undergoes a heat-releasing (exothermic) reaction during its hardening process.

Vertebral Augmentation
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.

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.

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

Setting
Patients with osteoporotic vertebral compression fractures are managed by orthopedic surgeons, endocrinologists, physical therapists, and primary care providers in an outpatient clinical setting. Vertebroplasty procedures would be performed in an inpatient setting.

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

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

Balloon Kyphoplasty vs Conservative Care
Wardlaw et al (2009) reported on the FREE trial, a nonblinded industry-sponsored, multisite RCT in which 300 adults with 1 to 3 painful osteoporotic vertebral compression fractures (VCFs) of less than 3 months in duration were assigned to kyphoplasty or conservative care.[12,] Twenty-four-month results were reported by Boonen et al (2011) and by Van Meirhaeghe et al (2013).[13,14,] Scores for the primary outcome, 1-month change in the 36-Item Short-Form Health Survey Physical Component Summary score, were significantly higher for those in the kyphoplasty group. The difference between groups was 5.2 points (95% confidence interval [CI], 2.9 to 7.4 points; p<0.001). Kyphoplasty was associated with greater improvements in the 36-Item Short-

Form Health Survey Physical Component Summary scores at 6-month follow-up (3.39 points), but not at 12- or 24-month follow-ups. Greater improvement in back pain was observed over 24 months for kyphoplasty (-1.49 points) and remained statistically significant at 24 months. Participants in the kyphoplasty group also reported greater improvements in QOL 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.

Edidin et al (2011) reported on mortality risk in Medicare patients who had VCFs and had been treated with vertebroplasty, kyphoplasty, or nonoperatively.[15,] This study was industry-funded. Using the U.S. Medicare dataset, the authors identified 858978 patients who had VCFs between 2005 and 2008. The dataset included 119253 kyphoplasty patients and 63693 vertebroplasty patients. Survival was calculated from the index diagnosis date until death or the end of follow-up (up to four 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.

Table 2. Summary of Key RCT Characteristics

Study	Countries	Sites	Dates	Participants	Interventions	
					Active	Comparator
Wardlaw (2009)[12,]	EU	21	2003-2005	Patients with 1-3 vertebral fractures	Balloon kyphoplasty (n=149)	Non-surgical care (n=151)
Boonen (2011)[13,]	EU	21	2003-2005	Patients with 1-3 vertebral fractures	Balloon kyphoplasty (n=149)	Non-surgical care (n=151)
Van Meirhaeghe (2013)[14,]	EU	21	2003-2005	Patients with 1-3 vertebral fractures	Balloon kyphoplasty (n=149)	Non-surgical care (n=151)

Table 3. Summary of Key RCT Results

Study	Mean SF 36 PCS Score Improvement at 1 mo.	Difference in SF 36 Scores between Groups at 24 mo	Serious Adverse Events within 12 mo.	Serious.Adverse.Events.within.24.mo.	Serious Adverse Events within 30 days
Wardlaw (2009)[12,]					
Kyphoplasty	7.2		58 (38.9%)		
95% CI	5.7-8.8				
Control	2		54 (35.8%)		
95% CI	0.4-3.6				
P value	<0.0001				
Boonen (2011)[13,]		3.24 (95% CI 1.47-5.01)			
Kyphoplasty				74 (49.7%)	
Control				73 (48.3%)	
P value		0.0004			

Study	Mean SF 36 PCS Score Improvement at 1 mo.	Difference in SF 36 Scores between Groups at 24 mo	Serious Adverse Events within 12 mo.	Serious.Adverse.Events.within.24.mo.	Serious Adverse Events within 30 days
Van Meirhaeghe (2011)[14],		2.71 (95% CI 1.34-4.09			
Kyphoplasty					24 (16.1%)
Control					17 (11.3%)
P-value		<0.0001			

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

Table 4. Relevance Study Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow.Up[e]
Wardlaw (2009)[12],			3. Non-surgical treatment was not standardized		2. 12 mo. follow-up
Boonen (2011)[13],			3. Non-surgical treatment was not standardized		
Van Meirhaeghe (2013)[14],					

The evidence gaps 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 5. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective.Reporting[c]	Follow.Up[d]	Power[e]	Statisticalf
Wardlaw (2009)[12],	3. Allocation concealment unclear	1,2. Not blinded				
Boonen (2011)[13],	3. Allocation concealment unclear	1,2. Not blinded				
Van Meirhaeghe (2013)[14],						

The evidence gaps 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.

Unilateral Balloon Kyphoplasty vs Bilateral Balloon Kyphoplasty

Xiang et al (2018) reviewed the literature through April 2017, evaluating the role of unilateral balloon kyphoplasty and conducted a meta-analysis to compare the efficacy and safety of unilateral and bilateral kyphoplasty in patients with OVCF[16,]. The meta-analysis included 9 studies, 6 RCTs and 3 retrospective comparative studies, on the use of unipedicular balloon in the treatment of 870 patients with OVCFs. The patients were followed for periods ranging from 2 weeks to 42.2 months with a mean age of 68.85 years. After unilateral balloon kyphoplasty, the mean postoperative visual analog score (VAS) ranged from 1.74 to 4.77, mean postoperative kyphotic angle ranged from 5.9º to 11.22º, and complications involving cement leaks ranged from 6.8 to 21.9% or adjacent level fractures was from 0 to 5.6%). Unilateral kyphoplasty had significantly shorter operative time, and less bone-cement volume; however, the postoperative VAS, Oswestry Disability Index (ODI), vertebral height restoration rate, and cement leakage and adjacent vertebral fracture rate, were similar to bilateral kyphoplasty. The meta-analysis had several inherent weaknesses. The sample size (six RCTs and three retrospective comparative studies) limited the level of evidence for the analysis. Heterogeneity was also detected among the studies once they were pooled. In addition, incomplete data recording was discovered once clinical outcomes were extracted and pooling this data could lead to bias.

Section Summary

Based on the available evidence from the meta-analysis conducted by Xiang et al (2018), unilateral and bilateral balloon kyphoplasty have similar outcomes for the treatment of OCVs. Unilateral kyphoplasty had shorter operation time and radiation exposure. More RCTs are warranted to compare these surgical options.

Balloon Kyphoplasty vs Vertebroplasty

Systematic Reviews

Wang et al (2018) published a meta-analysis and systematic review aimed at exploring the overall safety and efficacy of balloon kyphoplasty vs percutaneous vertebroplasty for OVCF based on qualified studies using a search of multiple databases up to January 2018[17,] Qualified studies included were RCTs, prospective or retrospective comparative studies, and cohort studies. Sixteen studies were included in the meta-analysis with 647 subjects in the kyphoplasty group and 758 subjects in the vertebroplasty group. The patients were from Israel, Australia, Japan, Canada, Italy, Slovenia, USA, Spain, Germany, China, and Korea. The age of the patients in both groups was over 60 years. The results indicated that kyphoplasty significantly decreased the kyphotic wedge angle (standard mean difference: 0.98; 95% CI 0.40-1.57), increased the postoperative vertebral body height (standard mean difference, −1.27; 95% CI −1.86 to −0.67), and decreased the risk of cement leakage (relative risk, 0.62; 95% CI 0.47–0.80) in comparison with vertebroplasty. However, there was no statistical difference in VAS scores (weighted mean difference, 0.04; 95% CI − 0.28–0.36) and ODI scores (weighted mean difference, − 1.30; 95% CI − 3.34–0.74) between the two groups. The study is limited in that there are differences in the inclusion and exclusion criteria for patients between studies and a bias source could stem from the inclusion of only studies published in English and Chinese. Further, the operating techniques in the various studies differed and the low-quality of included studies and the number of included studies is limited. Lastly, pooled data were used for analysis and individual patients' data were not available which limited a more comprehensive analysis.

Chang et al (2015) reported on a meta-analysis of prospective studies that compared vertebroplasty with kyphoplasty.[18,] Included were 6 RCTs and 14 prospective comparative studies (totaln=1429 patients). Outcomes were compared for the short (≤1 week after surgery) and long (>6 months) terms. The time to perform vertebroplasty was significantly shorter than kyphoplasty. There was no significant difference between groups inVAS pain scores or Oswestry Disability Index (ODI scores at either short- or long-term follow-up. There was no significant difference between treatments in adjacent-level fractures. Cobb angle at long-term follow-up was improved in the kyphoplasty group compared with vertebroplasty. Kyphoplasty had a

significantly lower number of procedures with cement extravasion, although the percentage of cases with cement leakage is high for both procedures. For example, an RCT by Dohm et al (2014; KAVIAR study) reported overall cement extravasion in 157 (73.4%) of 214 levels treated with kyphoplasty compared with 164 (81.6%) of 201 levels treated with vertebroplasty (p=0.047).[18] Intravascular cement extravasion occurred in 59 (27.6%) of 214 levels treated with kyphoplasty compared with 76 (37.8%) of 201 levels treated with vertebroplasty. The clinical significance of a 10% difference in cement extravasion is uncertain; the occurrences of device-related cement embolism were similar, with 1 (0.5%) case in each group. Kyphosis correction was better in the kyphoplasty group by 1.42° (p=0.036). Pain and function improvements were similar for both procedures.

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.[19,] Sixteen RCTs were identified (totaln=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: VAS, the 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 review was limited by significant heterogeneity across measured outcomes and length of follow-up in studies; the presence of performing and reporting bias in studies was also a concern.

Table 6. Systematic Reviews & Meta-Analysis Characteristics

Study	Dates	Trials	Participants	N..Range.	Design	Duration
Chang (2015)[18,]	2005-2014	20	Patients with osteoporotic vertebral compression fracture	1429 (NR)	RCT, Prospective	NR
Zhao (2017)[19,]	2006-2016	16	Patients with osteoporotic vertebral compression fracture	2046	RCT	NR
Wang (2018)[17,]	2005-2016	16	Patients with osteoporotic vertebral compression fracture	1405 (40-192)	Prospective, retrospective	NR

RCT: randomized controlled trial; NR: no response.

Table 7. Systematic Reviews & Meta-Analysis Results

Study	SMD.in.Cobb.Angle.Reduction	SMD.in.Long.term.VAS.Scores	VAS.Scores	Decrease.in.Kyphotic.Wedge.Angle
Chang (2015)[18,]	-0.61	-.25		
95% CI	0.49-2.32	-0.57 to 0.07		
P-value	0.003	0.12		
Zhao (2017)[19,]				
MD			-1.12	
95% CI			-1.80 to -0.51	
Wang (2018)[17,]			(WMD) 0.04	(SMD) 0.98

Study	SMD.in.Cobb.Angle.Reduction	SMD.in.Long.term.VAS.Scores	VAS.Scores	Decrease.in.Kyphotic.Wedge.Angle
95% CI			-0.28 to 0.36	0.40 to 1.57

SMD: standard mean difference; WMD: weighted mean difference; CI: confidence interval; MD: mean difference; VAS: visual analog score.

Section Summary: Balloon Kyphoplasty vs Vertebroplasty
Three systematic reviews with metanalyses compared vertebroplasty and kyphotoplasty for outcomes including efficacy, pain relief, daily function, QOL, and included data for up to six months post operation. The studies each had limiting factors that lessened their evidentiary value and increased the potential for bias. Overall, the differences between balloon kyphoplasty and vertebroplasty were either not significant or data was not sufficient.

Mechanical Vertebral Augmentation with Kiva vs Balloon Kyphoplasty
Vertebral augmentation with the Kiva VCF System was compared with balloon kyphoplasty in a pivotal noninferiority RCT reported by Tutton et al (2015).[20,] This industry-sponsored, multicenter open-label Kiva Safety and Effectiveness Trial was conducted in 300 patients with 1 or 2OVCFs. 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 ODI scores of at least 30%. The primary composite endpoint at 12 months was a reduction in fracture pain by at least 15 mm on the 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 on a randomized trial of 180 patients with OVCFs that compared mechanical vertebral augmentation with the Kiva device with balloon kyphoplasty in 180 patients withOVCFs.[21,] The groups showed similar improvements in VAS scores for back pain, 36-Item Short-Form Health Survey 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 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 two patients treated with balloon kyphoplasty, necessitating decompression, compared with none following the Kiva procedure.

Table 9. Summary of Key RCT Characteristics

Study	Countries	Sites	Dates	Participants	Interventions	X
					Active	Comparator
Tutton (2015)[20,]	US, EU	21	2010-2013	Patients with OVCF	Kiva (n=153)	BK (n=147)
Korovessis (2013)[21,]	Greece	1	2010-2011	Patients with OVCF	Kiva (n=82 patients, 133 fractures)	BK (n=86 patients, 122 fractures)

BK: balloon kyphoplasty; OVCF: osteoporotic vertebral compression fracture; RCT: randomized controlled trial.

Table 9. Summary of Key RCT Results

Study	Improvement in VAS Score at 12 mo.	Improvement in Oswestry Disability Index at 12 mo	Restoration of AVBHr	VAS Improvement of 5.5 Points
Tutton (2015)[20],				
Kiva	70.8	38.1		
BK	71.8	42.2		
Korovessis (2013)[21],				
Kiva			24%	44 (54%)
BK			23%	37 (43%)
P-value			0.97	

RCT: randomized controlled trial; BK: balloon kyphoplasty; VAS: visual analog scale.

Table 10. Relevance Study Limitations

Study	Population[a]	Intervention[b]	Comparator[c]	Outcomes[d]	Follow Up[e]
Tutton (2015)[20],					2. 12 mo. follow-up
Korovessis (2013)[21],					2. Average 14 mo. follow-up

The evidence gaps 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 11. Study Design and Conduct Limitations

Study	Allocation[a]	Blinding[b]	Selective.Reporting[c]	Follow.Up[d]	Power[e]	Statistical[f]
Tutton (2015)[20],	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)[21],		1,2. Not blinded				

The evidence gaps 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: OVCF
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. Other relevant studies, including additional RCTs and meta-analysis studies, found similar outcomes for kyphoplasty and vertebroplasty.

For mechanical vertebral augmentation with Kiva, evidence includes a large industry-sponsored, multicenter investigational device exemption trial and a large independent randomized trial. These randomized comparative trials showed outcomes similar to kyphoplasty.

Osteolytic Vertebral Compression Fractures
Clinical Context and Therapy Purpose
The purpose of balloon kyphoplasty or mechanical vertebral augmentation (Kiva)is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as conservative care, in patients with osteolytic vertebral compression fractures.

The question addressed in this evidence review is: does the use of balloon kyphoplasty or mechanical vertebral augmentation improve the net health outcome for individuals who have OVCF or osteolytic VCF?

The following PICOTS were used to select literature to inform this review.

Patients
The relevant population of interest are individuals with osteolytic VCF.

Interventions
The therapy being considered is balloon kyphoplasty or mechanical vertebral augmentation (Kiva). The intervention involves the fluoroscopically guided injection of PMMApo 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, in a home setting as well as an outpatient clinical setting by a primary care provider.

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

Table 12. Outcomes of Interest for Individuals with osteolytic vertebral compression fractures

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

Timing
The existing literature evaluating balloon kyphoplasty or mechanical vertebral augmentation (Kiva)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.

Setting
Patients with osteolytic VCF are actively managed by orthopedic surgeons, endocrinologists, physical therapists, and primary care providers in an outpatient clinical setting. Vertebroplasty procedures are performed in the inpatient setting.

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

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

In a systematic review, Health Quality Ontario (2016) assessed vertebral augmentation for cancer-related VCFs.[22] The assessment identified 33 reports with 1690 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 QOL 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.

Berenson et al (2011) reported on the results of an international multicenter RCT.[23] They enrolled 134 patients with cancer who were at least 21 years of age. Participants had at least one and not more than three painful VCFs. The primary outcome was change in functional status from baseline at one month as measured by the RMDQ. Treatment allocation was not blinded, and the primary outcome at one month was analyzed using all participants with data both at baseline and at one month. Participants needed to have a pain score of at least four, on a 0-to-10 scale. Crossover to the balloon kyphoplasty arm was allowed after one 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, $p<0.001$).

Section Summary: Osteolytic VCF
Results of RCTs and case series would 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 evidence review is: does the use of RFK improve the net health outcome for individuals who have OVC For osteolytic VCF?

The following PICOTS were used to select literature to inform this review.

Patients
The relevant population of interest are 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, in a home setting as well as an outpatient clinical setting by a primary care provider.

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

Table 13. Outcomes of Interest for Individuals with osteoporotic or osteolytic vertebral compression fractures

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

Timing
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.

Setting
Patients with osteoporotic or osteolytic VCFare actively managed by orthopedic surgeons, endocrinologists, physical therapists, and primary care providers in an outpatient clinical setting.

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

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

Petersen et al (2016) reported on an RCT with 80 patients that compared RFK with balloon kyphoplasty.[24,] Patients had been admitted to the hospital for severe back pain and met criteria for surgery after failed conservative treatment. All had osteoporotic compression fractures. Before treatment, 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.

Feng et al (2017) performed a meta-analysis comparing RFK with balloon kyphoplasty in patients with VCFs.[25,] Six studies (totaln=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.

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 2 months for 59.2% of conservatively treated patients. All patients were evaluated with radiographs and magnetic resonance imaging at six 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).

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.

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

Summary of Evidence
For individuals who have OVCF who receive balloon kyphoplasty, or mechanical vertebral augmentation (Kiva), the evidence includes RCTs and meta-analyses. The relevant outcomes include symptoms, functional outcomes, QOL, hospitalizations, and treatment-related morbidity. A meta-analysis and moderately sized unblinded RCT have compared kyphoplasty with conservative care and found short-term benefits in pain and other outcomes. Other RCTs, summarized in a meta-analysis, have reported similar outcomes for kyphoplasty and vertebroplasty. Two randomized trials that compared mechanical vertebral augmentation (Kiva) 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 the effects of the technology on health outcomes.

For individuals who have osteolytic VCF who receive balloon kyphoplasty or mechanical vertebral augmentation (Kiva), the evidence includes RCTs, case series, and a systematic review of these studies. The relevant outcomes include symptoms, functional outcomes, QOL, 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 the effects of the technology on health outcomes.

For individuals who have osteoporotic or osteolytic VCF who receive RFK, the evidence includes a systematic review and an RCT. The relevant outcomes include symptoms, functional outcomes, QOL, hospitalizations, and treatment-related morbidity. The only RCT (n=80) identified

showed similar results between RFK and balloon kyphoplasty. The systematic review suggested that RFK 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 would be needed to determine with greater certainty whether RFK provides outcomes similar to balloon kyphoplasty. The evidence is insufficient to determine the effects of the technology on health outcomes.

SUPPLEMENTAL INFORMATION

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 severe pain has led to hospitalization or persists at a level that prevents ambulation, and on the treatment of traumatic fractures that have remained symptomatic after six weeks of conservative treatment. Clinical input on these issues was mixed.

2008 Input

In response to requests from Blue Cross Blue Shield Association, input was received from 6 physician specialty societies (1 unsolicited) and 2 academic medical centers in 2008. All reviewers disagreed with the proposed policy, referring to a body of evidence from uncontrolled studies that supported the use of kyphoplasty.

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.

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 non ambulatory 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."[28] 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 the 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.[29] 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).[30] 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.

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 14.

Table 14. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Ongoing			
NCT02461810[a]	A Prospective, Multicenter, Randomized, Comparative Clinical Study to Compare the Safety and Effectiveness of Two Vertebral Compression Fracture (VCF) Reduction Techniques: the SpineJack® and the KyphX Xpander® Inflatable Bone Tamp	152	Feb 2018 (ongoing)

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

References

1. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous kyphoplasty for vertebral fractures caused by osteoporosis and malignancy. TEC Assessments. 2004;Volume 19:Tab 12.
2. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous kyphoplasty for vertebral fractures caused by osteoporosis or malignancy. TEC Assessments. 2005;Volume 20:Tab 7.

3. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis or malignancy. TEC Assessments. 2008;Volume 23:Tab 5.
4. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis. TEC Assessments. 2009;Volume 24:Tab 7.
5. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis. TEC Assessments. 2010;Volume 25:Tab 9.
6. 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.
7. 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.
8. 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.
9. 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.
10. Buchbinder R, Osborne RH, Ebeling PR, et al. A randomized trial of vertebroplasty for painful osteoporotic vertebral fractures. N Engl J Med. Aug 6 2009;361(6):557-568. PMID 19657121.
11. Kallmes DF, Comstock BA, Heagerty PJ, et al. A randomized trial of vertebroplasty for osteoporotic spinal fractures. N Engl J Med. Aug 6 2009;361(6):569-579. PMID 19657122.
12. 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.
13. 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.
14. 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.
15. 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.
16. Xiang GH, Tong MJ, Lou C, et al. The Role of Unilateral Balloon Kyphoplasty for the Treatment of Patients with OVCFS: A Systematic Review and Meta-Analysis. Pain Physician. 2018 May;21(3):209-218. PMID: 29871365.
17. Wang B, Zhao CP, Song LX et al. Balloon kyphoplasty versus percutaneous vertebroplasty for osteoporotic vertebral compression fracture: a meta-analysis and systematic review. J Orthop Surg Res. 2018 Oct 22;13(1):264. PMID: 30348192.
18. Chang X, Lv YF, Chen B, et al. Vertebroplasty versus kyphoplasty in osteoporotic vertebral compression fracture: a meta-analysis of prospective comparative studies. Int Orthop. Mar 2015;39(3):491-500. PMID 25260399.
19. 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.
20. 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.
21. 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.
22. Health Quality Ontario. Vertebral augmentation involving vertebroplasty or kyphoplasty for cancer-related vertebral compression fractures: a systematic review. Ont Health Technol Assess Ser. May 1 2016;16(11):1-202. PMID 27298655.
23. Berenson J, Pflugmacher R, Jarzem P, et al. Balloon kyphoplasty versus non-surgical fracture management for treatment of painful vertebral body compression fractures in patients with cancer: a multicentre, randomised controlled trial. Lancet Oncol. Mar 2011;12(3):225-235. PMID 21333599.
24. 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.
25. 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.
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. American Academy of Orthopaedic Surgeons (AAOS). The treatment of sumptomatic osteoporotic spinal compression fractures: Guideline and evidence report. 2010; http://www.aaos.org/research/guidelines/SCFguideline.pdf. Accessed March 26, 2018.
29. 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 March 26, 2018.
30. National Institute for Health and Care Excellence (NICE). Metastatic spinal cord compression in adults: risk assessment, diagnosis and management [CG75]. 2014; https://www.nice.org.uk/guidance/cg75/chapter/1- Guidance. Accessed March 26, 2018.
31. Blue Cross Blue Shield Association. Medical Policy Reference Manual, No. 6.01.38 (April 2019).

Documentation for Clinical Review

Please provide the following documentation (if/when requested):

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

Post Service

- 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. Inclusion or exclusion of codes does not constitute or imply member coverage or provider reimbursement.

MN/IE

The following services may be considered medically necessary in certain instances and investigational in others. Services may be considered medically necessary when policy criteria are met. Services may be considered investigational when the policy criteria are not met or when the code describes application of a product in the position statement that is investigational.

Type	Code	Description
CPT®	22513	Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (e.g., kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging guidance; thoracic
	22514	Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (e.g., kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging guidance; lumbar
	22515	Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device (e.g., kyphoplasty), 1 vertebral body, unilateral or bilateral cannulation, inclusive of all imaging guidance; each additional thoracic or lumbar vertebral body (List separately in addition to code for primary procedure)
HCPCS	None	
ICD-10 Procedure	0PU33JZ	Supplement Cervical Vertebra with Synthetic Substitute, Percutaneous Approach
	0PU34JZ	Supplement Cervical Vertebra with Synthetic Substitute, Percutaneous Endoscopic Approach
	0PU43JZ	Supplement Thoracic Vertebra with Synthetic Substitute, Percutaneous Approach
	0PU44JZ	Supplement Thoracic Vertebra with Synthetic Substitute, Percutaneous Endoscopic Approach
	0QU03JZ	Supplement Lumbar Vertebra with Synthetic Substitute, Percutaneous Approach
	0QU04JZ	Supplement Lumbar Vertebra with Synthetic Substitute, Percutaneous Endoscopic Approach
	0QU13JZ	Supplement Sacrum with Synthetic Substitute, Percutaneous Approach
	0QU14JZ	Supplement Sacrum with Synthetic Substitute, Percutaneous Endoscopic Approach

Policy History

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

Effective Date	Action	Reason
02/14/2001	New Policy Adoption Policy for Vertebroplasty	Medical Policy Committee
10/24/2001	New Policy Adoption Policy for Kyphoplasty	Medical Policy Committee
11/05/2002	Policy Revision Addition of FDA notification to description	Administrative Review

Effective Date	Action	Reason
03/01/2005	Policy Revision MPC Adoption CTAF Consent review of BCBSA TEC 2004 Vol. 24, No. 12 & 13. Policy Updated.	Medical Policy Committee
10/01/2005	Policy Name Change Policy review, title modifications	Administrative Review
12/01/2005	Policy Revision MPC Adoption CTAF Consent review of BCBSA TEC Vol.20, No. 6 & 7. Policy Updated.	Medical Policy Committee
12/01/2006	BCBSA Medical Policy adoption MPC adopted BCBSA MPP review for Percutaneous Vertebroplasty 4:2006 & Percutaneous Kyphoplasty	Medical Policy Committee
10/15/2007	Policy Revision Policy changed based on expert input and evidence review. Approved under certain conditions (see policy for details).	Medical Policy Committee
06/19/2009	Policy Revision	Medical Policy Committee
03/30/2012	Policy Name Change Combination of two BCBSA medical policies: Percutaneous Vertebroplasty and Sacroplasty (6.01.25) and Percutaneous Kyphoplasty (6.01.38)	Administrative Review
07/06/2012	Policy title change from Percutaneous Kyphoplasty and Vertebroplasty with position change	Medical Policy Committee
07/13/2012	Coding Update	Administrative Review
12/15/2014	Policy title change from Percutaneous Kyphoplasty, Vertebroplasty and Sacroplasty Policy revision with position change	Medical Policy Committee
04/08/2015	Coding update	Administrative Review
08/31/2015	Policy revision with position change	Medical Policy Committee
01/01/2017	Policy revision without position change	Medical Policy Committee
10/01/2017	Policy title change from Percutaneous Balloon Kyphoplasty and Mechanical Vertebral Augmentation Policy revision without position change	Medical Policy Committee
06/01/2018	Policy revision without position change	Medical Policy Committee
06/01/2019	Policy revision without position change	Medical Policy Committee

Definitions of Decision Determinations

Medically Necessary: A treatment, procedure, or drug is medically necessary only when it has been established as safe and effective for the particular symptoms or diagnosis, is not investigational or experimental, is not being provided primarily for the convenience of the patient or the provider, and is provided at the most appropriate level to treat the condition.

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. Please call (800) 541-6652 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.