

Medical Policy



An Independent Licensee of the
Blue Cross and Blue Shield Association

Title: **Percutaneous Vertebroplasty, Kyphoplasty and Sacroplasty**

Professional

Original Effective Date: October 18, 2004
Revision Date(s): April 21, 2005;
September 7, 2005; December 14, 2005;
February 21, 2006; May 9, 2006;
July 27, 2006; September 14, 2006;
October 31, 2006; January 1, 2007
July 23, 2009; January 1, 2012;
October 4, 2013; December 31, 2013
Current Effective Date: December 31, 2013

Institutional

Original Effective Date: July 1, 2005
Revision Date(s): September 7, 2005;
December 14, 2005; February 21, 2006;
May 9, 2006; July 27, 2006;
September 14, 2006; October 31, 2006;
January 1, 2007; July 23, 2009;
January 1, 2012; October 4, 2013;
December 31, 2013
Current Effective Date: December 31, 2013

State and Federal mandates and health plan member contract language, including specific provisions/exclusions, take precedence over Medical Policy and must be considered first in determining eligibility for coverage. To verify a member's benefits, contact [Blue Cross and Blue Shield of Kansas Customer Service](#).

The BCBSKS Medical Policies contained herein are for informational purposes and apply only to members who have health insurance through BCBSKS or who are covered by a self-insured group plan administered by BCBSKS. Medical Policy for FEP members is subject to FEP medical policy which may differ from BCBSKS Medical Policy.

The medical policies do not constitute medical advice or medical care. Treating health care providers are independent contractors and are neither employees nor agents of Blue Cross and Blue Shield of Kansas and are solely responsible for diagnosis, treatment and medical advice.

If your patient is covered under a different Blue Cross and Blue Shield plan, please refer to the Medical Policies of that plan.

DESCRIPTION

Percutaneous vertebroplasty and kyphoplasty are interventional techniques involving the fluoroscopically guided injection of polymethylmethacrylate (PMMA) through a needle inserted into a weakened vertebral body. The technique has been investigated as an option to provide mechanical support and symptomatic relief in patients with osteoporotic vertebral compression fracture or in those with osteolytic lesions of the spine, i.e., multiple myeloma or metastatic malignancies. Percutaneous vertebroplasty has also been investigated as an adjunct to surgery for aggressive vertebral body hemangiomas, as a technique to limit blood loss related to surgery.

Percutaneous Vertebroplasty

It has been proposed that vertebroplasty 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, including thermal damage to intraosseous nerve fibers, since PMMA undergoes a heat-releasing (exothermic) reaction during its hardening process.

Percutaneous Kyphoplasty

Balloon kyphoplasty is a variant of vertebroplasty and uses of specialized bone tamp with an inflatable balloon to expand collapsed vertebral body as close as possible to its natural height before injection of the PMMA. Radiofrequency kyphoplasty is a modification of balloon kyphoplasty. In this procedure, ultrahigh viscosity cement is injected into the fractured vertebral body, and radiofrequency is used to achieve the desired consistency of the cement. The ultrahigh viscosity cement is designed to restore height and alignment to the fractured vertebra, along with stabilizing the fracture.

Percutaneous Sacroplasty

Sacroplasty evolved from the treatment of insufficiency fractures in the thoracic and lumbar vertebrae with vertebroplasty. The procedure, essentially identical, entails guided injection of PMMA through a needle inserted into the fracture zone. While first described in 2001 as a treatment for symptomatic sacral metastatic lesions, (1, 2) it is most often described as a minimally invasive procedure employed as an alternative to conservative management (3-5) for sacral insufficiency fractures (SIFs). SIFs are the consequence of excessive stress on weakened bone and are often the cause of low back pain among the elderly population. Osteoporosis is the most common risk factor for SIF.

Osteoporotic Vertebral Compression Fracture

Osteoporotic compression fractures are a common problem, and it is estimated that up to one-half of women and approximately one-quarter of men will have a vertebral fracture at some point in their lives. However, only about one-third of vertebral fractures actually reach clinical diagnosis, and most symptomatic fractures will heal within a few weeks or 1 month. However, a minority of patients will exhibit chronic pain following osteoporotic compression fracture that presents challenges for medical management. Chronic symptoms do not tend to respond to the management strategies for acute pain such as bed rest, immobilization/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.

Sacral Insufficiency Fractures

Spontaneous fracture of the sacrum in patients with osteoporosis was described by Lourie in 1982 and presents as lower back and buttock pain with or without referred pain in the legs. (6, 7) Although common, SIFs can escape detection due to low provider suspicion and poor sensitivity on plain radiographs, slowing the application of appropriate intervention. Similar interventions are used for sacral and vertebral fractures including bed rest, bracing, and analgesics. Initial clinical improvements may occur quickly; however, the resolution of all symptoms may not occur for 9 to 12 months. (6, 8)

Vertebral/Sacral Body Metastasis

Metastatic malignant disease involving the spine generally involves the vertebrae/sacrum, with pain being the most frequent complaint. While radiation and chemotherapy are frequently effective in reducing tumor burden and associated symptoms, pain relief may be delayed days to weeks, depending on tumor response. Further, these approaches rely on bone remodeling to regain strength in the vertebrae/sacrum, which may necessitate supportive bracing to minimize the risk of vertebral/sacral collapse during healing.

Vertebral Hemangiomas

Vertebral hemangiomas are relatively common lesions noted in up to 12% of the population based on autopsy series; however, only rarely do these lesions display aggressive features and produce neurologic compromise and/or pain. Treatment of aggressive vertebral hemangiomas has evolved from radiation therapy to surgical approaches using anterior spinal surgery for resection and decompression. There is the potential for large blood loss during surgical resection, and vascular embolization techniques have been used as adjuncts to treatment to reduce blood loss.

Percutaneous vertebroplasty has been proposed as a way to treat and stabilize some hemangioma to limit the extent of surgical resection and as an adjunct to reduce associated blood loss from the surgery.

Regulatory Status

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

POLICY

- I. Percutaneous vertebroplasty or kyphoplasty may be considered **medically necessary**:
 - A. The treatment of severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies; **OR**
 - B. Vertebral hemangiomas with pain, nerve compression or aggressive radiologic signs, and radiation therapy has failed to relieve symptoms; **OR**
 - C. Painful vertebral eosinophilic granuloma; **OR**
 - D. The treatment of MRI documented acute osteoporotic vertebral compression fractures with persistent debilitating pain that have failed to respond to conservative treatment (e.g., rest with graduated activity, back bracing, analgesics, physical therapy, and calcitonin) for at least 6 weeks or these treatments are contraindicated.; **OR**

- E. The treatment of MRI / bone scan documented acute osteoporotic vertebral compression fractures with persistent debilitating pain requiring hospital admission and parenteral narcotics for treatment.
- II. Percutaneous vertebroplasty or kyphoplasty is considered **experimental / investigational** for all other indications, including use in acute vertebral fractures due to trauma.
- III. Percutaneous sacroplasty is considered **experimental / investigational** for all indications, including use in sacral insufficiency fractures due to osteoporosis and spinal lesions due to metastatic malignancies or multiple myeloma.

RATIONALE

For treatment of osteoporosis and malignancy with percutaneous vertebroplasty, kyphoplasty or sacroplasty, the primary beneficial outcomes of interest are relief of pain and improvement in ability to function. Ex vivo cadaver studies reporting bone strength as a surrogate outcome measure have been reported but are not included in this evaluation of health outcomes. In treatment of aggressive hemangioma, the primary benefits of percutaneous vertebroplasty include relief of pain and reduction of blood loss associated with surgical treatment.

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

In all clinical situations, adverse effects related to complications from vertebroplasty and sacroplasty are the primary harms to be considered. Principal safety concerns relate to the incidence and consequences of leakage of the injected PMMA.

Percutaneous Vertebroplasty

The evidence on this question consists of a number of randomized clinical trials (RCTs), 2 of which included a sham control, and many case series. This policy was originally based on a 2000 TEC Assessment and updated with TEC Assessments in 2004, 2005, 2008, 2009, and 2010. (9-14) Originally, the available data were observational. The largest of the case series reported results from a prospectively collected database with 552 patients from a large academic department. (15) Evidence from observational studies were generally consistent in showing significant decreases in pain from an initial preoperative level of 8 to 9 on a visual analog scale (VAS, or similar score proportionate to the highest possible score) to 2 to 4, typically within 1 day of receiving the procedure. Such pain relief appeared to be lasting in the limited studies that reported long-term outcomes. In terms of adverse outcomes, leakage of the cement outside of the vertebral body was a common event, occurring in between 19% and 72% in studies that reported its occurrence.

Beginning in 2007, data from RCTs began appearing in the literature. This policy is now focused on RCT data.

RCTs of Vertebroplasty versus Medical Management with Sham Controls

In 2009, 2 randomized trials compared vertebroplasty to a medical management using a sham placebo control (that included local anesthetic), which mimicked the vertebroplasty procedure up to the point of cement injection. (16, 17) Buchbinder and colleagues reported results of a 4-center, randomized, double-blind, sham-controlled trial that was designed to determine short-term efficacy and safety of vertebroplasty for alleviating pain and improving physical functioning in persons with painful osteoporotic vertebral fractures. A total of 78 participants with 1 or 2 painful osteoporotic vertebral fractures of duration less than 1 year were assigned to undergo vertebroplasty or sham procedure (i.e., injection of local anesthetic into the facet capsule and/or periosteum). (16) Ninety-one percent of participants completed 6-months of follow-up. The participants, investigators (other than the radiologists performing the procedure), and outcome assessors were blind to the treatment assignment.

Recruitment took place within the practices of both general practitioners and specialists from hospital inpatient and emergency departments. In general, participants were required to have back pain of no more than 12 months and the presence of at least 1 but no more than 2 recent vertebral fractures. Participants were evaluated at baseline, then with a mailed questionnaire at 1 week and 1, 3, and 6 months after the procedure. The primary outcome was overall pain (over the course of the previous week) measured on a 0 to 10 VAS, with 1.5 representing the minimal clinically important difference. A sample size of 24 per group was calculated to provide 80% power with 2-sided α 0.05 to show a 2.5-point post-procedure difference assuming a 3-point standard deviation (SD). All analyses were performed according to intention-to-treat principles. Results are presented as difference from baseline. For the primary outcome of overall pain, the authors reported no significant difference in VAS pain score at 3 months. With reductions in pain and improvements in quality of life observed in both groups, the authors concluded vertebroplasty provided no benefit.

There was considerable variability in pain scores, which may in part be due to a lack of minimum pain score at entry. The primary outcome measure was the mean difference in VAS from baseline. For some continuous outcomes, such as pain, there is a magnitude of improvement that is clinically meaningful on an individual level; someone achieving that minimal change can be considered a responder. Under these circumstances, a fundamental limitation of continuous effect measures is failing to identify the proportion of patients experiencing a meaningful clinical response. (18) Since a clinically meaningful important improvement has been established, the proportion of patients responding is an informative outcome that can supplement and extend the comparison of mean differences. (19) Moreover, when considered in this manner, response or meaningful improvement (2.5 on the VAS) in overall pain at 1, 3, and 6 months tended to be more frequent with vertebroplasty—respective relative risks (RRs) of 1.2 (95% confidence interval [CI]: 0.7 to 2.0), 1.5 (95% CI: 0.9 to 2.6), and 1.3 (95% CI: 0.8 to 2.1). However, detecting an increase in clinical response rates often requires larger numbers of patients. For example, detecting an increase in response from 40% (sham) to 60% with 80% power would have required a sample exceeding 200 participants. Also, at entry, many participants had experienced pain longer than 3 months, (20) suggesting that the VAS may not be as responsive as other measures for these patients. (20) This adds to the uncertainty as to whether a mean change in VAS will capture clinically meaningful improvement.

Kallmes et al. conducted a multicenter, randomized, double-blind, sham-controlled trial in which 131 participants with 1 to 3 painful osteoporotic vertebral fractures were assigned to undergo vertebroplasty or sham procedure (injection of local anesthetic into the facet capsule and/or periosteum). (17) Participants had back pain for no more than 12 months and had a current pain rating of at least 3 on VAS at baseline. Participants were evaluated at baseline, then again at various time points to 1-year post-procedure. Ninety-seven percent completed a 1-month follow-up, and 95% completed 3 months. The primary outcomes were scores on the Roland-Morris Disability Questionnaire (RMDQ) and average back pain intensity during the preceding 24 hours at 1 month, with a reduction of 30% on the RMDQ and VAS pain considered a clinically meaningful difference. (21) The study initially had 80% power to detect differences in both primary and secondary outcomes with 250 patients, with a 2-sided alpha of 0.05 on the basis of a 2.5-unit advantage for vertebroplasty over placebo on the RMDQ and 1.0 point difference on VAS. After recruitment difficulty and interim analysis on the first 90 participants, target sample size was decreased to 130 participants with 80% power for primary aims maintained. All primary analyses were performed according to intention-to-treat principles and results presented as mean score for the RMDQ and pain intensity.

For the primary endpoints at 1 month, there were no significant between group differences. There was a trend toward a higher clinically meaningful improvement in pain at 1 month (30% reduction from baseline) in the vertebroplasty group (64% vs. 48%, respectively; $p=0.06$). At 3 months, 43% from the control group vs. 12% in the vertebroplasty group crossed over ($p<0.001$). The crossovers did not affect study outcomes, as they occurred after the primary outcome assessment. However, significantly more participants in the control group chose to cross over than in the vertebroplasty group.

Staples and colleagues conducted a patient-level meta-analysis of the 2 sham-controlled trials to determine whether vertebroplasty is more effective than sham in specific subsets of patients. (22) This subset analysis focused on duration of pain (< 6 weeks vs. > 6 weeks) and severity of pain (score < 8 or > 8 on an 11-point numerical rating scale). Included in the analysis were 209 participants (78 from the Australian trial and 131 from the U.S. trial); 27% had pain of recent onset and 47% had severe pain at baseline. The primary outcome measures, pain scores and function on the RMDQ at 1 month, were not significantly different between groups. Responders' analyses were also conducted based on a 3-unit improvement in pain scores, a 3-unit improvement on the RMDQ, and a 30% improvement in each of the pain and disability outcomes. The only difference observed between groups was a trend for a higher proportion of the vertebroplasty group to achieve at least 30% improvement in pain scores (RR: 1.32, 95% CI: 0.98 to 1.76, $p=0.07$), a result that may have been confounded by the greater use of opioid medications in that group. Overall, this analysis does not support the hypothesis that selected subgroups of patients, including those with pain of 6 weeks' duration or less or those with severe pain, would benefit from vertebroplasty.

RCTs of Vertebroplasty versus Medical Management without Sham Controls

VERTOS II, reported by Klazen et al. in 2010, was an open-label prospective randomized trial of 202 patients at 6 hospitals in the Netherlands and Belgium. (23) Participants with at least one painful osteoporotic vertebral fracture of a duration of 6 weeks or less were assigned to undergo vertebroplasty or conservative management (i.e., bed rest, analgesia, and cast and physical support). Ninety-three participants received vertebroplasty, while 95 received conservative management; 81% of participants completed 1-year follow-up. The trial was designed to assess the efficacy of vertebroplasty compared to conservative management for the treatment of

osteoporotic vertebral compression fractures. There was no blinding of participants, investigators, or outcome assessors to treatment assignment, due to the lack of a sham procedure.

Participants were recruited after referral from their primary care provider for spine radiography because of back pain. In general, participants were required to be at least 50 years of age or older, have compression fracture with height loss of the vertebral body of at least 15% on x-ray of the spine, the level of fracture was Th5 or lower back with pain of a duration of 6 weeks or less with a severity of at least 5 on the VAS. Participants were clinically evaluated at baseline, 1 day, 1 week, 1 month, 3 months, 6 months and 12 months after treatment. Primary outcome was pain relief at 1 month and 12 months measured on a 10-point VAS scale. A sample size of 100 per group was calculated to provide 80% power with an alpha of 0.05 to show a 25% difference in pain relief. All analyses were performed according to intention-to-treat principles. Clinically significant pain relief was defined as 30% change on the VAS (0-10 scale).

One hundred and one participants were enrolled into the treatment group and 101 into the control arm; 81% completed 12 months' follow-up. Except for the primary outcome, difference in mean pain score from baseline at 3 months and 12 months, vertebroplasty resulted in greater pain relief than did medical management at 1 month and 1 year; there were significant between group differences at 1 month (2.6; 1.74 to 3.37, $p<0.0001$) and at 1 year (2.0; 1.13 to 2.80, $p<0.0001$). Survival analysis showed significant pain relief was quicker (29.7 vs. 115.6 days) and was achieved in more patients after vertebroplasty than after conservative management. There was cement leakage in 72% of patients after vertebroplasty with all patients remaining asymptomatic, and at a mean of 11.4 months' follow-up, there was no significant difference in number of new fractures between groups, with 18 new fractures in 15 patients who had vertebroplasty compared to 30 new fractures in 21 participants undergoing medical management.

A methodologic strength of this study is the study's focus on acute fracture, a subset of those with osteoporotic vertebral compression fractures, while other studies (Buchbinder et al. 2009 [16]; Kallmes et al. 2009 [17]) enrolled participants with pain out to 1 year. The inclusion of both chronic and acute fractures may mask the efficacy of the procedure in one subset. Klazen and colleagues also provided an a priori definition of clinically significant change in pain as one that registered a 30% difference on the 10-point VAS. (23) These data were incorporated as events in a survival analysis as part of the analysis of the primary outcome.

A subsequent report from the VERTOS II study described the 12-month natural history of pain in patients in the conservative treatment arm. (24) Patients in the control arm were followed until pain relief was achieved, defined as a VAS score of 3 or less. Results were analyzed by Kaplan-Meier survival analysis. By 12-month follow-up, 57 of 95 patients (60%) were considered to have sufficient pain relief, with most experiencing sufficient pain relief in the first 3 months. Comparison by logistic regression analysis with the 38 patients (40%) who still had pain (VAS > 4) at 12 months did not reveal any significant differences between the groups for the clinical and imaging factors that were evaluated.

In 2011, Farrokhi and colleagues reported a randomized trial that compared vertebroplasty with optimal medical management in 82 patients. (25) Patients had painful osteoporotic vertebral compression fractures that were refractory to analgesic therapy for at least 4 weeks and less than 1 year. The patients and the physicians involved in the treatment of the patients were not aware of the treatment that the other group was receiving. Control of pain and improvement in quality of life were measured by independent raters before treatment and at 1 week and 2, 6, 12, 24, and 36

months after the beginning of treatment. Radiological evaluation to measure vertebral body height and correction of deformity was performed before and after treatment and after 36 months of follow-up. At 1 week, the mean VAS score decreased from 8.4 to 3.3 in the vertebroplasty group and from 7.2 to 6.4 in the conservative management group, with between group differences that remained significant through 6 months of follow-up. Group differences on the Oswestry lower back pain score were significantly lower in the vertebroplasty group throughout the 36 months of the study. New symptomatic adjacent fractures developed in 1 patient (2.6%) in the vertebroplasty group and 6 patients (15.4%) in the conservative management group. In 1 patient, epidural cement leakage caused severe lower extremity pain and weakness that was treated with bilateral laminectomy and evacuation of bone cement.

Rousing et al. (26) reported on a nonblinded randomized trial in which participants were randomized to either vertebroplasty or conservative management. These participants had no conservative therapy prior to enrolling in the trial. The study enrolled 40 participants with acute fractures and 10 with subacute (2–8 weeks). While immediate pain relief was observed in the vertebroplasty group, reductions in pain from baseline to 3-month follow-up were similar in the two groups. The authors concluded that conservative management should be used in the acute phase. The primary limitations of this study include its small size and incomplete pain assessment at the baseline visit.

The VERTOS study was a small randomized clinical trial of 34 patients. (27) Patients had been refractory to medical management for at least 6 weeks and no longer than 6 months. The authors noted that many patients had been referred for vertebroplasty following failed conservative treatment and did not want to be randomized to the optimized medication control group or chose to crossover to vertebroplasty after only 2 weeks of conservative treatment. Thus, the follow-up in the study was very short. Vertebroplasty was found to decrease analgesic use (1.9 to 1.2 vs. 1.7 to 2.6 in the optimized medication group) and resulted in a 19% improvement in the RMDQ (vs. -2% in controls) 2 weeks following the procedure. Excluding 2 patients (11%) who had adjacent vertebral compression fractures by the 2-week follow-up, mean VAS scores for pain decreased from 7.1 to 4.4 (vs. 7.6 to 6.4 for controls). Patients who crossed over from conservative management to vertebroplasty had improvements after the procedure.

Conclusions.

Despite the completion of 5 RCTs, including 2 with sham control, the efficacy of vertebroplasty for painful osteoporotic compression fractures remains uncertain. The 2 randomized, sham-controlled trials concluded that vertebroplasty showed no significant benefit above sham for painful osteoporotic fractures. However some uncertainty remains around the interpretation of their conclusions. While the use of a sham procedure is a major methodologic strength to control for nonspecific (placebo) effects, the sham used in the trial is not without controversy, as it might be considered an active control, given that the effect of injecting local anesthetic in the facet capsule and/or periosteum is unknown. Without a clear understanding of the short- and long-term effects of the injection on pain, questions will remain. Also, both trials were underpowered to observe and compare the proportion of participants experiencing a clinically meaningful difference in pain, which is the most clinically relevant outcome measure. Furthermore, the responder outcome measures in both trials showed trends toward an improvement in the rate of meaningful clinical response, although the differences between groups were not statistically significant.

In contrast, the 4 RCTs without sham control report that vertebroplasty is associated with significant improvements in pain. Three of the 4 trials were small, and the studies included populations with different time periods of symptoms and different prior treatments. It is possible that the effect reported in these non-sham controlled trials is due to a placebo effect, given that these studies were not blinded and the outcome of pain is a subjective, patient-reported outcome that is prone to the placebo effect. It is also possible that the differences in these trials represents a true treatment effect and that the sham control had a therapeutic effect in reducing short-term pain, thus obscuring any impact of vertebroplasty.

Other Studies

Although not randomized, there was one other comparative study specifically aimed at patients with acute fracture. Diamond et al. enrolled 79 consecutive patients with acute vertebral fractures. (28) All patients were offered vertebroplasty, and those who declined were followed as a comparison group. The 2 groups had balanced baseline characteristics. At 24 hours, the group undergoing vertebroplasty (n=55) had much improved pain compared to the control group (n=24). However, at 6 weeks and between 6 and 12 months, there were no differences between groups in pain scores. The control group had an identical mean pain score to the vertebroplasty group at the end of follow-up. Similar findings were shown for the Barthel index of physical functioning. At long-term follow-up, there was still slightly higher functioning in the group undergoing vertebroplasty but no difference in the percent improvement from baseline between groups. The authors interpreted these findings as demonstrating that vertebroplasty produced faster resolution of symptoms than conservative management, as was shown in the Klazen trial.

In 2011, Edidin et al. reported mortality risk in Medicare patients who had vertebral compression fractures and had been treated with vertebroplasty, kyphoplasty or nonoperatively. (29) This study was industry-funded. Using the U.S. Medicare data set, they identified 858,978 patients who had vertebral compression fractures 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 was used to evaluate the joint effect of multiple covariates, which included gender, 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 operated cohort (vertebroplasty or kyphoplasty) were found to have a higher adjusted survival rate (60.8%) than patients in the nonoperated 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 relationship cannot be determined from this study.

A systematic review of the safety and efficacy of vertebroplasty in malignancy was reported by Chew et al. in 2011. (30) Thirty relevant studies were identified, totaling 987 patients. Included in the review were a single randomized controlled trial and 7 prospective studies. Most centers reported treating no more than 4 vertebrae per session. Pain reduction ranged between 20% to 79%. Five deaths were attributable to vertebroplasty, 2 from chest infections following general anesthesia, 1 from a cement pulmonary embolus, and 2 from sepsis after emergency spinal decompression. Another 19 patients suffered a serious complication related to the procedure, with 13 requiring emergency spinal decompression. Reports of complications occurred in studies with a mean cement volume of more than 4 mL, suggesting a possible association between the volume of cement injected and adverse events.

Percutaneous Kyphoplasty

Beginning in 2009, data from randomized clinical trials (RCTs) began appearing in the literature. This policy is now focused on RCT data.

Osteoporotic Compression Fractures

In 2009, Wardlaw et al. reported on the findings of an industry-sponsored multisite RCT in which 300 adult participants with 1 to 3 painful osteoporotic vertebral fractures of less than 3 months' duration were assigned to undergo kyphoplasty or conservative care. (56) Twenty-four month results of this study were reported by Boonen et al. in 2011. (57) This study was designed to examine efficacy and safety of kyphoplasty for the treatment of acute vertebral compression fractures. There was no blinding in this trial. Participants were recruited from 21 sites in 8 countries. Participants needed to have back pain of no more than 3 months' duration and the presence of at least one but no more than 3 acute vertebral fractures. Participants were evaluated at baseline, then at 1, 3, 6, 12, and 24 months after the procedure. The primary outcome was the difference in change from baseline to 1 month in the SF-36 physical component summary (PCS) between the kyphoplasty and control groups.

A total of 138 participants who underwent kyphoplasty and 128 control patients completed 1 month of follow-up. Scores for the primary outcome, 1-month change in SF-36 PCS score, were significantly higher for those in the kyphoplasty group. The difference between the 2 groups was 5.2 points (95% confidence interval [CI]: 2.9–7.4; $p <0.0001$). Data were available from 232 patients (77%) at 24 months. 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 months. 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 score 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%). While not a study outcome, the authors also noted that patients who received kyphoplasty had approximately 60 fewer days of restricted activity during the year than controls. Other differences between the groups were no longer apparent at 12 months; possibly due to natural healing of fractures. At 24 months, there was no significant difference between groups in the number of patients with new radiographic vertebral fractures (47.5% for kyphoplasty, 44.1% for control). Two device-related serious adverse events (a spondylitis and an anterior cement migration) were reported.

Berenson and colleagues reported the results of an international randomized multicenter clinical trial in 2011. (58) They enrolled 134 patients with cancer who were at least 21 years of age. Participants had at least one and not more than 3 painful vertebral compression fractures (VCF). (These appear to be due to osteoporosis, rather than from a metastatic lesion.) The primary outcome was change in functional status from baseline at 1 month as measured by the Roland Morris Disability Questionnaire (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 0-10 scale. Crossover to the balloon kyphoplasty arm was allowed after 1 month. The authors report scores in the kyphoplasty and nonsurgical groups of 17.6 and 18.2 at baseline, respectively, and 9.10 and 18.0 at 1-month follow-up. P-value for the between group difference in scores $p=0.0001$.

In 2011, Edidin et al. reported mortality risk in Medicare patients who had vertebral compression fractures and had been treated with vertebroplasty, kyphoplasty, or nonoperatively. (59) This study was industry-funded. Using the U.S. Medicare data set, they identified 858,978 patients who had vertebral compression fractures 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 was used to evaluate the joint effect of multiple covariates, which included gender, 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 operated cohort (vertebroplasty or kyphoplasty) were found to have a higher adjusted survival rate (60.8%) than patients in the nonoperated 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 relationship cannot be determined from this study.

Conclusions:

Two moderate-sized unblinded RCTs report short-term benefits for kyphoplasty on pain and other outcomes in patients with painful osteoporotic fractures. Similar results are seen in numerous case series that report large short-term improvements in pain following kyphoplasty. There are no sham-controlled RCTs that have been completed for this technique.

The major limitation of these RCTs was the lack of a sham procedure. Nonspecific or placebo effects can be quite large for an invasive procedure such as kyphoplasty in which there is not blinding. (60, 61) Due to the possible sham effect observed in the recent trials of vertebroplasty, the validity of results from non-sham-controlled trials are questionable. The placebo effect may be substantial, on the order of 6 to 7 mm on a 100-mm scale, for invasive procedures, (60-62) and even larger effects (10%) were observed in the sham-controlled vertebroplasty trials (64, 65) The analyses were appropriate; however, it would have been preferable to have the number of participants reporting a clinically meaningful change as the primary outcome. In cases of chronic pain, mean differences in continuous measures may not be reflective of the percent of patients who have a meaningful clinical response.

Due to the concerns about the validity of the available RCTs, it is difficult to come to conclusions regarding the efficacy of kyphoplasty. Despite most case series showing consistent improvements in pain after the procedure, and the same conclusion being reached in the 2 RCTs, it is not possible to conclude that these improvements are a true treatment effect, or a non-specific, placebo effect. (66)

Vertebral Body Metastasis

In the early literature reviews, 3 case series were reviewed evaluating a total of 52 patients. (26-28) Outcome measures varied among these 3 studies, but all showed improvements either in VAS pain score, several aspects of physical functioning as measured by SF-36, or improvement in a disability score. There are no RCTs of kyphoplasty for vertebral body metastasis. Because the results of the comparative studies of vertebroplasty suggest possible placebo or natural history effects, case series are insufficient to make conclusions about the effect of kyphoplasty on health outcomes.

Vertebral Hemangiomas

For symptomatic vertebral body hemangioma with aggressive features, no studies reported pre- and post-procedure pain evaluations. Therefore, the findings of all studies that reported more than a single case (6 studies, totaling 64 patients) were evaluated. The studies using percutaneous cementoplasty as an adjunct to surgical treatment suggest that the use of percutaneous cementoplasty to treat the vertebral body component of the vascular lesion may contribute to avoiding the substantial blood loss that has been historically described with primary surgical resection (curettage). However, the additional use of other procedures in these studies may make it difficult to attribute the lower blood loss to this procedure. These studies do not provide controlled comparisons of the morbidity of treating hemangiomas with percutaneous cementoplasty as an adjunct to surgery and the morbidity of surgical treatment without cementoplasty.

Percutaneous Sacroplasty

Sacroplasty is an evolving technique with numerous methods (short axis, long axis, balloon-assisted short axis, and iliosacral screws). No randomized trials of sacroplasty have been reported. Published evidence is mostly from case reports (31-35) and small case series (all but one enrolling fewer than 13 patients). (36-45) No consensus for best practices has been published. The largest experience is a prospective observational cohort study of 52 consecutive patients undergoing sacroplasty for sacral insufficiency fractures using the short axis technique. (46) Patients had a mean age of 75.9 years and a mean duration of symptoms of 34.5 days (range: 4-89 days) and mean VAS score of 8.1 at baseline. Improvement on the VAS scale was measured at 30 minutes and 2, 4, 12, 24, and 52 weeks postprocedure. At each interval, statistically significant improvement over baseline was observed and maintained through 52 weeks. Additional literature reports are mostly consistent reporting immediate improvement following the procedure. Due to the small size of the evidence base, harms associated with sacroplasty have not been adequately studied. There are complications of cement leakage with sacroplasty that are not observed with vertebroplasty. Leakage of polymethylmethacrylate (PMMA) into the presacral space, spinal canal, sacral foramen, or sacroiliac joint may result in pelvic injection of PMMA, sacral nerve root or sacral spinal canal compromise, or sacroiliac joint dysfunction. (47) Performing sacroplasty on Zone 1 fractures only can minimize these risks. (48)

Summary

After consideration of the available evidence and uniform clinical input, it was concluded that although the scientific evidence does not permit conclusions about the impact on health outcomes and that comparative studies with long-term outcomes are lacking; numerous case series, including large prospective reports, consistently showed that vertebroplasty or kyphoplasty may alleviate pain and improve function in patients with vertebral fractures who fail to respond to conservative treatment (at least 6 weeks) with analgesics, physical therapy, and rest. More recent randomized trials that compare kyphoplasty with medical management have also reported benefit. Given the absence of alternative treatment options and the morbidity associated with extended bed rest, kyphoplasty may be considered a reasonable treatment option in patients with vertebral fractures who fail to improve after 6 weeks of conservative therapy, and therefore may be considered medically necessary both for this patient population, as well as for patients who have severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies.

Subsequent literature updates performed after 2008, including 2 sham-controlled trials, have raised questions about the efficacy of vertebroplasty for osteoporotic fractures. These trials can be interpreted as showing that vertebroplasty is ineffective. However, alternate interpretations are possible. There are methodologic issues with these studies, including but not limited to the choice

of sham procedure and the potential effect of the sham procedure having a therapeutic effect by reducing pain. Also, the appropriateness of chosen outcome measures to detect clinically meaningful differences in pain may not have been optimal, as the studies were underpowered to detect differences in clinical response rates.

There is insufficient evidence to permit conclusions on the use of vertebroplasty or kyphoplasty for acute fractures. The VERTOS II trial (28) is a well-done study, whose results should be replicated and verified. For acute fractures, conservative therapy consisting of rest, analgesics and physical therapy is an option, and symptoms will resolve in a large percentage of patients with conservative treatment only. Therefore, the use of vertebroplasty for acute osteoporotic fractures is considered investigational.

Sacroplasty is under development. Varying techniques, patient indications, and small numbers of treated patients leaves uncertainty regarding the impact of sacroplasty on health outcomes and does not permit conclusion on its use for sacral insufficiency fractures or other indications. Therefore, sacroplasty is considered investigational.

Practice Guidelines and Position Statements

In 2010, the American Academy of Orthopaedic Surgeons (AAOS) Board of Directors approved a new clinical practice guideline on the treatment of osteoporotic spinal compression fractures, which is available online at: <http://www.aaos.org/Research/guidelines/SCFguideline.asp>. The Board approved a strong recommendation against the use of vertebroplasty for patients who "present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically 'intact.' " In coming out with a strong recommendation, the committee expressed their confidence that future evidence is unlikely to overturn the existing evidence. As a note, these recommendations were based on a literature review through September 2009; therefore, the Klazen et al. trial was not included in the systematic review. The Board approved a weak recommendation for offering the option of kyphoplasty for patients who "present with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms and who are neurologically intact". In coming out with a weak recommendation, the committee expressed that future evidence could overturn the existing evidence and that the quality of the current literature is poor. As a note, these recommendations were based on a literature review through September 2009.

The United Kingdom's National Institute for Health and Clinical Excellence (NICE) concluded in 2003 and 2006 that the current evidence on the safety and efficacy of balloon vertebroplasty for vertebral compression fractures appears adequate to support the use of this procedure to provide pain relief for people with severe painful osteoporosis with loss of height and/or compression fractures of the vertebral body, and also for people with symptomatic vertebral hemangioma and painful vertebral body tumors (metastases or myeloma), provided that normal arrangements are in place for consent, audit, and clinical governance. (49, 50) The guidance recommends that the procedure be limited to patients whose pain is refractory to more conservative treatment.

A 2007 joint position from the American Society of Interventional and Therapeutic Neuroradiology, Society of Interventional Radiology, American Association of Neurological Surgeons/Congress of Neurological Surgeons, and American Society of Spine Radiology ("the Societies") states that, "percutaneous vertebral augmentation with vertebroplasty and kyphoplasty is a safe, efficacious, and durable procedure in appropriate patients with symptomatic osteoporotic and neoplastic fractures when performed in a manner in accordance with published standards. These procedures

are offered only when traditional medical therapy has not provided pain relief or pain is substantially altering the patient's lifestyle." (51)

Guidelines from the American College of Radiology (ACR, 2006) consider percutaneous vertebroplasty appropriate for painful osteoporotic or neoplastic vertebral compression fracture(s) refractory to medical therapy. (52) It is noted that when fewer than 95% of percutaneous vertebroplasty in an institution are performed for the above indication, it should prompt a review of practices related to selection of patients for this procedure. The guidelines also list absolute contraindications of asymptomatic vertebral body compression fractures, including patient improving on medical therapy; nonfractured vertebral levels; prophylaxis in osteoporotic patients (unless being performed as part of a research protocol); osteomyelitis of the target vertebra; myelopathy originating at the fracture level; uncorrectable coagulopathy; allergy to bone cement or opacification agent. Relative contraindications are listed as radiculopathy in excess of local vertebral pain, caused by a compressive syndrome unrelated to vertebral collapse (occasionally preoperative percutaneous vertebroplasty can be performed before a spinal decompressive procedure); asymptomatic retropulsion of a fracture fragment causing significant spinal canal compromise; asymptomatic tumor extension into the epidural space; ongoing systemic infection.

The ACR published guidelines on the management of vertebral compression fractures in 2010. (53) While generally supportive of vertebroplasty and kyphoplasty in specified conditions, the guidelines state that "conservative management is the first-line and gold standard treatment of painful vertebral compression fractures....Most patients with osteoporotic vertebral compression fractures, even without medication, have spontaneous resolution of pain within 4 to 6 weeks from the initial onset of pain. From the inception of vertebral augmentation in the late 1980s, its minimally invasive procedures have been reserved for patients who have failed conservative therapy. Failure can be defined as pain refractory to oral medications (NSAIDs and/or narcotic) over 6-12 weeks. However, failure can also be defined as contraindications to such medications or a requirement for parenteral narcotics and hospital admission."

Indications and contraindications similar to those provided by the ACR were described by the Society of Interventional Radiology (SIR) in 2003. (54)

Official Disability Guidelines (ODG) (70):

"Recommended as an option for patients with pathologic fractures due to vertebral body neoplasms, who may benefit from this treatment, but under study for other vertebral compression fractures, consistent with recent higher quality discouraging studies of a similar procedure, vertebroplasty (Kallmes, 2009) (Buchbinder, 2009), and if used for osteoporotic compression fractures should be restricted to selected patients failing other interventions (including bisphosphonate therapy) with significant unresolving pain. However, a recent study has suggested that kyphoplasty is no better than vertebroplasty for osteoporotic compression fractures. (Liu, 2010) There may be highly selected patients who were outside the scope of the two high quality trials of vertebroplasty above, who might still derive benefit from these procedures, for example, with three or more multiple simultaneous compression fractures despite bisphosphonate therapy, or pathologic fractures due to vertebral body neoplasms. (McGirt, 2009) This procedure had been recommended for patients with delayed healing of vertebral compression fractures. In patients with osteolytic fractures secondary to multiple myeloma, kyphoplasty yields quick pain relief, and is associated with a statistically significant improvement in generic health outcome measures. (Lieberman, 2003) (Garfin, 2002) A recent systematic review of 69 clinical studies concluded that a large proportion of subjects had some pain relief, including 87% with vertebroplasty and 92% with

kyphoplasty; vertebral height restoration was possible using kyphoplasty and for a subset of patients using vertebroplasty; cement leaks occurred for 41% and 9% of treated vertebrae for vertebroplasty and kyphoplasty, respectively; and new fractures of adjacent vertebrae occurred for both procedures at rates that are higher than the general osteoporotic population but approximately equivalent to the general osteoporotic population that had a previous vertebral fracture. (Hulme, 2006) Balloon kyphoplasty can be performed with low periprocedural morbidity and can result in clinical improvement, report investigators in the first large, randomized, long-term study of spinal augmentation, known as the Fracture Reduction Evaluation (FREE) trial, published in *The Lancet*. Although the trial results point to the safety and efficacy of kyphoplasty, investigators note that the benefits were not long lasting. For most outcome measures, the differences between kyphoplasty treatment and control were diminished at 12 months, because the nonsurgical group improved over time, probably as a result of fracture healing. Spinal augmentation procedures, including balloon kyphoplasty and vertebroplasty, have been in routine clinical use for more than a decade, but this is the first large, randomized trial to confirm previous case reports and smaller trials suggesting benefit. (Wardlaw, 2009) (Kyphoplasty is a newer procedure, and some clinicians have concluded it is superior to vertebroplasty.)

Recent research: A prospective randomized clinical study comparing balloon kyphoplasty versus vertebroplasty for treatment of osteoporotic vertebral compression fracture with 6-month follow up concluded that there was little difference in outcome between the treatment groups. (Liu, 2010) This study of clinical and radiological results after kyphoplasty in patients with vertebral body compression fractures due to spinal metastasis and multiple myeloma concluded that kyphoplasty is a safe and effective procedure for this condition. (Dalbayrak, 2010) This cohort study concluded that kyphoplasty presents a very safe and effective procedure for the treatment of vertebral osteolyses and fractures caused by multiple myeloma. (Huber, 2009) A recent technology assessment by the California Technology Assessment Forum (CTAF) recommended that balloon kyphoplasty with PMMA meets CTAF criteria for safety, effectiveness and improvement in health outcomes for the treatment of recent (< 3 month old) osteoporotic vertebral compression fractures confirmed by MRI, but it does not meet CTAF criteria for the treatment of chronic (>3 month old) osteoporotic, traumatic, or pathologic vertebral compression fractures. (Karliner, 2010) The AAOS made a strong recommendation against vertebroplasty for treatment of spinal compression fractures, but they said kyphoplasty may be an option for neurologically intact patients presenting with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms, but the strength of this recommendation was weak. (Esses, 2010) In this RCT of patients with an acute/subacute vertebral compression fracture due to osteoporosis, balloon kyphoplasty was not shown to be cost-effective compared with standard medical treatment. (Fritzell, 2011)

Indications for Surgery – Kyphoplasty

- (1) Presence of unremitting pain and functional deficits due to compression fracture from:
 - (a) Osteolytic metastasis, myeloma, hemangioma [Recommended]
 - (b) Osteoporotic compression fractures [Under study];
- (2) Lack of satisfactory improvement with medical treatment (e.g. medications, bracing, therapy);
- (3) Absence of alternative causes for pain such as herniated intervertebral disk by CT or MRI;
- (4) Affected vertebra is at least one third of its original height. (Ledlie, 2006)
- (5) Fracture age not exceeding 3 months, since studies did not evaluate older fractures.
For average hospital LOS if criteria are met, see Hospital length of stay (LOS)."

Official ODG Guidelines, Criteria for Percutaneous Vertebroplasty—(70)

"Not recommended based on recent higher quality studies. See recent research below. May be an option to treat multiple myeloma (MML) patients with nonosteoporotic vertebral compression fractures. (Erdem, 2010) This procedure had been recommended for patients with delayed healing of vertebral compression fractures. Percutaneous vertebroplasty (PV) is a treatment for relieving pain in patients complaining of severe back pain induced by osteoporotic or neoplastic compression fractures. The success rate may exceed 90% in noncomparative studies and the complication rate is lower than 1%. (Mathis, 2003) (Lieberman, 2003) (Garfin, 2002) A previous systematic review of 69 clinical studies concluded that a large proportion of subjects had some pain relief, including 87% with vertebroplasty and 92% with kyphoplasty; vertebral height restoration was possible using kyphoplasty and for a subset of patients using vertebroplasty; cement leaks occurred for 41% and 9% of treated vertebrae for vertebroplasty and kyphoplasty, respectively; and new fractures of adjacent vertebrae occurred for both procedures at rates that are higher than the general osteoporotic population but approximately equivalent to the general osteoporotic population that had a previous vertebral fracture. (Hulme, 2006) Acute osteoporotic vertebral compression fracture management includes bracing, analgesics, and functional restoration, and patients with chronic pain beyond 2 months may be candidates for vertebral body augmentation, ie, vertebroplasty, according to this study. (Kim, 2006) Up to 80 percent of patients with pain unresponsive to correct medical treatment experience a significant degree of pain relief, and few serious complications have been reported. However, relatively few patients have undergone this procedure, and there are no data from controlled clinical trials or from studies with long-term follow-up. At the present time this procedure is still in the investigational stages, but may be appropriate for patients with no other reasonable options for medical treatment. (Levine, 2000) This study showed significantly fewer refractures after vertebroplasty in patients who engage in back-extensor-strengthening exercises. (Huntoon, 2008) (Kyphoplasty is a newer procedure, and some clinicians have concluded it is superior to vertebroplasty.)

Recent research: Two new high-quality clinical trials, the first randomized controlled studies of this procedure, have shown that control-group patients experienced similar improvements to those treated with vertebroplasty for osteoporotic vertebral fractures. The authors concluded that, in view of the known potential adverse effects and no benefit, vertebroplasty should not be used in clinical practice. These results have changed vertebroplasty from a procedure that is virtually always considered to be successful to one that is considered no better than placebo. Previous studies of vertebroplasty probably overestimated the treatment effect by failing to take into account the natural history of painful vertebral fractures, which tend to improve over time. While patients are often in excruciating pain and have no other options, and this procedure is easy to do, augmentation should only be considered in a subset of patients, but new studies are necessary to identify who these patients might be. (Kallmes, 2009) (Buchbinder, 2009) There have been numerous examples of treatments that have looked promising in noncomparative studies but have subsequently been shown to be no better than placebo, a sham procedure, or standard care, including arthroscopy for osteoarthritis of the knee and high-energy shock-wave therapy for plantar fasciitis. Each of these looked promising early on, but didn't do well after rigorous study. There may be highly selected patients who were outside the scope of the two high quality trials above, who might still derive benefit from this procedure, for example, with three or more multiple simultaneous compression fractures despite bisphosphonate therapy, or pathologic fractures due to vertebral body neoplasms. (McGirt, 2009) Using vertebroplasty to treat multiple myeloma (MML) patients with nonosteoporotic vertebral compression fractures (VCF) reduces pain and disability. The recent news reports on the dangers of vertebroplasty has needlessly frightened millions of cancer sufferers who could have had vertebral augmentation to alleviate their pain. (Erdem, 2010)

A recent technology assessment by the California Technology Assessment Forum (CTAF) recommended that vertebroplasty does not meet CTAF criteria for safety, effectiveness and improvement in health outcomes for the treatment of osteoporotic vertebral compression fractures. (Karliner2, 2010) A recent manufacturer-sponsored RCT without any blinding concluded that vertebroplasty is effective and safe in a selected subgroup of patients with acute (but not subacute or chronic) osteoporotic vertebral fractures and persistent pain (30 days until significant pain relief versus 116 days with conservative treatment). (Klazen, 2010) The AAOS made a strong recommendation against vertebroplasty for treatment of spinal compression fractures, saying there is very strong Level 1 evidence to suggest that vertebroplasty does not provide the types of benefits that it was previously thought to provide. They said kyphoplasty may be an option for neurologically intact patients presenting with an osteoporotic spinal compression fracture on imaging with correlating clinical signs and symptoms, but the strength of this recommendation was weak. (Esses, 2010) The recent AAOS guideline on spinal compression fractures recommends against vertebroplasty based on strong evidence. (AAOS, 2010) Vertebroplasty does not meet California Technology Assessment Forum criteria for effectiveness. (CTAF, 2011) Individual patient data meta-analysis from two blinded trials of vertebroplasty, powered for subgroup analyses, failed to show an advantage of vertebroplasty over placebo for participants with recent onset fracture or severe pain. These results do not support the hypothesis that selected subgroups would benefit from vertebroplasty. Plus, at one month those in the vertebroplasty group were more likely to be using opioids. (Staples, 2011)

Criteria for percutaneous vertebroplasty (while Not recommended in ODG):

1. Severe debilitating pain or loss of mobility that cannot be relieved by correct medical therapy.
2. Other causes of pain, such as herniated intervertebral disk have been ruled out by computed tomography or magnetic resonance imaging.
3. The affected vertebra has not been extensively destroyed and is at least one third of its original height.

For average hospital LOS if criteria are met, see Hospital length of stay (LOS)."

From UpToDate (55):

"For treatment of osteoporotic thoracolumbar vertebral compression fractures:

The patient should be informed that fractures may take up to three months to heal and that pain will diminish gradually. Acute pain requires non-opioid or opioid analgesics and may require some limitation of activity.

For patients who do not have adequate pain relief with oral analgesics, we suggest adding nasal calcitonin for a two to four week course.

We do not recommend vertebroplasty or kyphoplasty for the acute management of pain due to osteoporotic compression fractures. In most patients with osteoporotic vertebral compression fracture, the acute pain resolves gradually over four to six weeks and completely resolves within three months. In some patients, the pain may persist beyond three months (sometimes due to paraspinal spasm). These modalities have not been adequately evaluated for the treatment of chronic pain."

CODING

The following codes for treatment and procedures applicable to this policy are included below for informational purposes. Inclusion or exclusion of a procedure, diagnosis or device code(s) does not constitute or imply member coverage or provider reimbursement. 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.

CPT/HCPCS

22520 Percutaneous vertebroplasty (bone biopsy included when performed), 1 vertebral body, unilateral or bilateral injection; thoracic

22521 Percutaneous vertebroplasty (bone biopsy included when performed), 1 vertebral body, unilateral or bilateral injection; lumbar

22522 Percutaneous vertebroplasty (bone biopsy included when performed), 1 vertebral body, unilateral or bilateral injection; each additional thoracic or lumbar vertebral body (List separately in addition to code for primary procedure)

22523 Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device, 1 vertebral body, unilateral or bilateral cannulation (eg, kyphoplasty); thoracic

22524 Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device, 1 vertebral body, unilateral or bilateral cannulation (eg, kyphoplasty); lumbar

22525 Percutaneous vertebral augmentation, including cavity creation (fracture reduction and bone biopsy included when performed) using mechanical device, 1 vertebral body, unilateral or bilateral cannulation (eg, kyphoplasty); each additional thoracic or lumbar vertebral body (List separately in addition to code for primary procedure)

72291 Radiological supervision and interpretation, percutaneous vertebroplasty or vertebral augmentation including cavity creation, per vertebral body; under fluoroscopic guidance

72292 Radiological supervision and interpretation, percutaneous vertebroplasty or vertebral augmentation including cavity creation, per vertebral body; under CT guidance

0200T Percutaneous sacral augmentation (sacroplasty), unilateral injection(s), including the use of a balloon or mechanical device (if utilized), 1 or more needles

0201T Percutaneous sacral augmentation (sacroplasty), bilateral injections, including the use of a balloon or mechanical device (if utilized), 2 or more needles

S2360 Percutaneous vertebroplasty, one vertebral body, unilateral or bilateral injection; cervical

S2361 Each additional cervical vertebral body (list separately in addition to code for primary procedure)

DIAGNOSIS

170.2 Malignant neoplasm of bone and articular cartilage; vertebral column, excluding sacrum and coccyx

198.5 Secondary malignant neoplasm of other specified sites; bone and bone marrow

203.00 Multiple myeloma and immunoproliferative neoplasms; multiple myeloma

203.01 Multiple myeloma and immunoproliferative neoplasms; plasma cell leukemia

228.09 Hemangioma, of other sites

238.6 Neoplasm of uncertain behavior or other and unspecified sites and tissues; plasma cells

733.00 Osteoporosis, unspecified

733.01 Senile osteoporosis

733.02 Idiopathic osteoporosis

733.03 Disuse osteoporosis
 733.13 Pathologic fracture of vertebrae

ICD-10 Diagnosis (*Effective October 1, 2014*)

C41.2 Malignant neoplasm of vertebral column
 C79.51 Secondary malignant neoplasm of bone
 C79.52 Secondary malignant neoplasm of bone marrow
 C90.00 Multiple myeloma not having achieved remission
 C90.01 Multiple myeloma in remission
 D18.09 Hemangioma of other sites
 D47.Z9 Other specified neoplasms of uncertain behavior of lymphoid, hematopoietic and related tissue
 M48.50xA Collapsed vertebra, not elsewhere classified, site unspecified, initial encounter for fracture
 M48.51xA Collapsed vertebra, not elsewhere classified, occipito-atlanto-axial region, initial encounter for fracture
 M48.52xA Collapsed vertebra, not elsewhere classified, cervical region, initial encounter for fracture
 M48.53xA Collapsed vertebra, not elsewhere classified, cervicothoracic region, initial encounter for fracture
 M48.54xA Collapsed vertebra, not elsewhere classified, thoracic region, initial encounter for fracture
 M48.55xA Collapsed vertebra, not elsewhere classified, thoracolumbar region, initial encounter for fracture
 M48.56xA Collapsed vertebra, not elsewhere classified, lumbar region, initial encounter for fracture
 M48.57xA Collapsed vertebra, not elsewhere classified, lumbosacral region, initial encounter for fracture
 M48.58xA Collapsed vertebra, not elsewhere classified, sacral and sacrococcygeal region, initial encounter for fracture
 M80.08xA Age-related osteoporosis with current pathological fracture, vertebra(e), initial encounter for fracture
 M80.88xA Other osteoporosis with current pathological fracture, vertebra(e), initial encounter for fracture
 M81.0 Age-related osteoporosis without current pathological fracture
 M81.8 Other osteoporosis without current pathological fracture
 M84.48xA Pathological fracture, other site, initial encounter for fracture
 M84.58xA Pathological fracture in neoplastic disease, vertebrae, initial encounter for fracture
 M84.68xA Pathological fracture in other disease, other site, initial encounter for fracture

REVISIONS

04-21-2005	Added "or kyphoplasty" to policy #C.
12-14-2005	In "Policy" section, #C., added 'and cervical percutaneous vertebroplasty and kyphoplasty' based on Radiology Liaison Committee recommendations from 02-12-2002.

	<p>In "Coding" CPT/HCPCS section, added CPT codes 22523, 22524, and 22525, and added "or vertebral augmentation including cavity creation" to CPT code 76012 to reflect changes in CPT book.</p> <p>In "Coding" CPT/HCPCS section, deleted HCPCS codes S2360 and S2361 because 'cervical' is considered E/I by the Radiology Liaison Committee 02-12-2002.</p>
12-21-2006	<p>In "Coding", Covered Diagnosis section, added Percutaneous vertebroplasty or Kyphoplasty – CPT Codes – 22520, 22521, 22522, 22523, 22524, 22525, 76012, 76013, S2362, S2363 to the current listing of diagnosis codes.</p>
07-27-2006 effective 10-01-2006	Deleted S2362 and S2363, the codes were deleted from HCPCS 4-1-06.
10-31-2006 effective 01-01-2007	In "Coding", CPT/HCPCS deleted CPT codes 76012 and 76013 and added CPT codes 72291 and 72292 due to the 2007 CPT changes.
07-23-2009	<p>Removed percutaneous vertebroplasty and kyphoplasty policy language from the policy entitled: Minimally Invasive Procedures for Spine Pain creating a free-standing policy entitled: Percutaneous Vertebroplasty, Kyphoplasty and Sacroplasty.</p> <p>Description section: Updated description to reflect discussion of percutaneous vertebroplasty, kyphoplasty and sacroplasty</p> <p>Policy section: Revised policy language from:</p> <p>C. Percutaneous vertebroplasty or kyphoplasty is considered medically necessary after failure of standard medical therapy in patients when any of the following criteria is met. Medical conditions not listed and cervical percutaneous vertebroplasty and kyphoplasty will be denied experimental/investigational.</p> <ol style="list-style-type: none"> 1. Osteolytic vertebral metastasis or myeloma with severe back pain related to destruction of the vertebral body not involving the major part of the cortical bone, and chemotherapy and radiation therapy have failed to relieve symptoms; or 2. Vertebral hemangiomas with aggressive clinical signs (severe pain or nerve compression) and/or aggressive radiological signs, and radiation therapy has failed to relieve symptoms; or 3. Osteoporotic vertebral collapse with persistent debilitating pain that has not responded to accepted standard medical therapy as documented in the medical records. Standard medical therapy may include initial bed rest with progressive activity, analgesics, physical therapy, bracing and exercises to correct postural deformity and increase muscle tone, salmon calcitonin, bisphosphonates and calcium supplementation; or 4. Painful vertebral eosinophilic granuloma with spinal instability. <p>To: Percutaneous vertebroplasty and kyphoplasty may be considered medically necessary for the treatment of: severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies vertebral hemangiomas with pain, nerve compression or aggressive radiologic signs, and radiation therapy has failed to relieve symptoms painful vertebral eosinophilic granuloma vertebral compression fracture with persistent debilitating pain</p>

	<p>Sacroplasty may be considered medically necessary for the treatment of sacral insufficiency fractures that have failed to respond to conservative treatment.</p> <p>Percutaneous vertebroplasty, kyphoplasty and sacroplasty are considered experimental / investigational for all other indications.</p> <p>Rationale section: Added Rationale section.</p> <p>Coding section: Added CPT/HCPCS Codes: 0200T, 0201T, S2360, S2361. Deleted ICD-9 Code: 213.2. Added ICD-9 Codes: 203.01, 238.6.</p>
01-01-2012	<p>In the Coding section: Revised CPT nomenclature for the following codes: 22520, 22521, 22522</p>
10-04-2013	<p>Added Medical Policy and Coding Disclaimers. Description section updated.</p> <p>In the Policy section:</p> <ul style="list-style-type: none"> Revised medical policy language from the following: Percutaneous vertebroplasty and kyphoplasty may be considered medically necessary for the treatment of: <ul style="list-style-type: none"> severe pain due to osteolytic lesions of the spine related to multiple myeloma or metastatic malignancies vertebral hemangiomas with pain, nerve compression or aggressive radiologic signs, and radiation therapy has failed to relieve symptoms painful vertebral eosinophilic granuloma osteoporotic vertebral compression fracture with persistent debilitating pain <p>Sacroplasty may be considered medically necessary for the treatment of sacral insufficiency fractures that have failed to respond to conservative treatment.</p> <p>Percutaneous vertebroplasty, kyphoplasty and sacroplasty are considered experimental / investigational for all other indications.</p> <p>Rationale section updated.</p> <p>In Coding section:</p> <ul style="list-style-type: none"> Added ICD-10 Diagnosis (<i>Effective October 1, 2014</i>) <p>Reference section updated.</p>
12-31-2013	<p>In Policy section:</p> <ul style="list-style-type: none"> In Item I, E, added "/bone scan" to read "The treatment of MRI / bone scan documented acute osteoporotic vertebral..."

REFERENCES

Percutaneous Vertebroplasty and Sacroplasty

1. Dehdashti AR, Martin JB, Jean B et al. PMMA cementoplasty in symptomatic metastatic lesions of the S1 vertebral body. *Cardiovasc Intervent Radiol* 2000; 23(3):235-7.
2. Marcy PY, Palussiere J, Descamps B et al. Percutaneous cementoplasty for pelvic bone metastasis. *Support Care Cancer* 2000; 8(6):500-3.
3. Aretxabala I, Fraiz E, Perez-Ruiz F et al. Sacral insufficiency fractures. High association with pubic rami fractures. *Clin Rheumatol* 2000; 19(5):399-401.

4. Leroux JL, Denat B, Thomas E et al. Sacral insufficiency fractures presenting as acute low-back pain. Biomechanical aspects. *Spine (Phila Pa 1976)* 1993; 18(16):2502-6.
5. Newhouse KE, el-Khoury GY, Buckwalter JA. Occult sacral fractures in osteopenic patients. *J Bone Joint Surg Am* 1992; 74(10):1472-7.
6. Gotis-Graham I, McGuigan L, Diamond T et al. Sacral insufficiency fractures in the elderly. *J Bone Joint Surg Br* 1994; 76(6):882-6.
7. Lourie H. Spontaneous osteoporotic fracture of the sacrum. An unrecognized syndrome of the elderly. *JAMA* 1982; 248(6):715-7.
8. Lin J, Lachmann E, Nagler W. Sacral insufficiency fractures: a report of two cases and a review of the literature. *J Womens Health Gend Based Med* 2001; 10(7):699-705.
9. Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous Vertebroplasty. TEC Assessments 2000; Volume 15, Tab 21.
10. Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty for vertebral fractures caused by osteoporosis, malignancy, or hemangioma. TEC Assessments 2004; Volume 19, Tab 13.
11. Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty for vertebral fractures caused by osteoporosis or malignancy. TEC Assessments 2005; Volume 20, Tab 6.
12. Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis or malignancy. TEC Assessments 2008; Volume 23, Tab 5.
13. Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty or kyphoplasty for vertebral fractures caused by osteoporosis. TEC Assessments 2009; Volume 24, Tab 7.
14. Blue Cross and Blue Shield Technology Evaluation Center (TEC). Percutaneous vertebroplasty for vertebral fractures caused by osteoporosis. TEC Assessments 2010; Volume 25, Tab 9.
15. Layton KF, Thielen KR, Koch CA et al. Vertebroplasty, first 1000 levels of a single center: evaluation of the outcomes and complications. *AJNR Am J Neuroradiol* 2007; 28(4):683-9.
16. Buchbinder R, Osborne RH, Ebeling PR et al. A randomized trial of vertebroplasty for painful osteoporotic vertebral fractures. *N Engl J Med* 2009; 361(6):557-68.
17. Kallmes DF, Comstock BA, Heagerty PJ et al. A randomized trial of vertebroplasty for osteoporotic spinal fractures. *N Engl J Med* 2009; 361(6):569-79.
18. Senn S. Statistical Issues in Drug Development. NY: Wiley and Sons; 2007.
19. Masala S, Massari F, Assako OP et al. Is 3T-MR spectroscopy a predictable selection tool in prophylactic vertebroplasty? *Cardiovasc Intervent Radiol* 2010; 33(6):1243-52.
20. Grotle M, Brox JI, Vollestad NK. Concurrent comparison of responsiveness in pain and functional status measurements used for patients with low back pain. *Spine (Phila Pa 1976)* 2004; 29(21):E492-501.
21. Ostelo RW, Deyo RA, Stratford P et al. Interpreting change scores for pain and functional status in low back pain: towards international consensus regarding minimal important change. *Spine (Phila Pa 1976)* 2008; 33(1):90-4.
22. Staples MP, Kallmes DF, Comstock BA et al. Effectiveness of vertebroplasty using individual patient data from two randomised placebo controlled trials: meta-analysis. *BMJ* 2011; 343:d3952.
23. Klazen CA, Lohle PN, de Vries J et al. Vertebroplasty versus conservative treatment in acute osteoporotic vertebral compression fractures (Vertos II): an open-label randomised trial. *Lancet* 2010; 376(9746):1085-92.

24. Venmans A, Klazen CA, Lohle PN et al. Natural History of Pain in Patients with Conservatively Treated Osteoporotic Vertebral Compression Fractures: Results from VERTOS II. *AJNR Am J Neuroradiol* 2011.
25. Farrokhi MR, Alibai E, Maghami Z. Randomized controlled trial of percutaneous vertebroplasty versus optimal medical management for the relief of pain and disability in acute osteoporotic vertebral compression fractures. *J Neurosurg Spine* 2011; 14(5):561-9.
26. Rousing R, Andersen MO, Jespersen SM et al. Percutaneous vertebroplasty compared to conservative treatment in patients with painful acute or subacute osteoporotic vertebral fractures: three-months follow-up in a clinical randomized study. *Spine (Phila Pa 1976)* 2009; 34(13):1349-54.
27. Voormolen MH, Mali WP, Lohle PN et al. Percutaneous vertebroplasty compared with optimal pain medication treatment: short-term clinical outcome of patients with subacute or chronic painful osteoporotic vertebral compression fractures. The VERTOS study. *AJNR Am J Neuroradiol* 2007; 28(3):555-60.
28. Diamond TH, Bryant C, Browne L et al. Clinical outcomes after acute osteoporotic vertebral fractures: a 2-year non-randomised trial comparing percutaneous vertebroplasty with conservative therapy. *Med J Aust* 2006; 184(3):113-7.
29. 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* 2011; 6(7):1617-26.
30. Chew C, Craig L, Edwards R et al. Safety and efficacy of percutaneous vertebroplasty in malignancy: a systematic review. *Clin Radiol* 2011; 66(1):63-72.
31. Garant M. Sacroplasty: a new treatment for sacral insufficiency fracture. *J Vasc Interv Radiol* 2002; 13(12):1265-7.
32. Layton KF, Thielen KR, Wald JT. Percutaneous sacroplasty using CT fluoroscopy. *AJNR Am J Neuroradiol* 2006; 27(2):356-8.
33. Sciubba DM, Wolinsky JP, Than KD et al. CT fluoroscopically guided percutaneous placement of transiliacal rod for sacral insufficiency fracture: case report and technique. *AJNR Am J Neuroradiol* 2007; 28(8):1451-4.
34. Smith DK, Dix JE. Percutaneous sacroplasty: long-axis injection technique. *AJR Am J Roentgenol* 2006; 186(5):1252-5.
35. Tjardes T, Paffrath T, Baethis H et al. Computer assisted percutaneous placement of augmented iliosacral screws: a reasonable alternative to sacroplasty. *Spine (Phila Pa 1976)* 2008; 33(13):1497-500.
36. Binaghi S, Guntern D, Schnyder P et al. A new, easy, fast, and safe method for CT-guided sacroplasty. *Eur Radiol* 2006; 16(12):2875-8.
37. Brook AL, Mirsky DM, Bello JA. Computerized tomography guided sacroplasty: a practical treatment for sacral insufficiency fracture: case report. *Spine (Phila Pa 1976)* 2005; 30(15):E450-4.
38. Butler CL, Given CA, 2nd, Michel SJ et al. Percutaneous sacroplasty for the treatment of sacral insufficiency fractures. *AJR Am J Roentgenol* 2005; 184(6):1956-9.
39. Deen HG, Nottmeier EW. Balloon kyphoplasty for treatment of sacral insufficiency fractures. Report of three cases. *Neurosurg Focus* 2005; 18(3):e7.
40. Gjertsen O, Schellhorn T, Nakstad PH. Fluoroscopy-guided sacroplasty: special focus on preoperative planning from three-dimensional computed tomography. *Acta Radiol* 2008; 49(9):1042-8.
41. Heron J, Connell DA, James SL. CT-guided sacroplasty for the treatment of sacral insufficiency fractures. *Clin Radiol* 2007; 62(11):1094-100; discussion 101-3.
42. Pommersheim W, Huang-Hellinger F, Baker M et al. Sacroplasty: a treatment for sacral insufficiency fractures. *AJNR Am J Neuroradiol* 2003; 24(5):1003-7.

43. Strub WM, Hoffmann M, Ernst RJ et al. Sacroplasty by CT and fluoroscopic guidance: is the procedure right for your patient? *AJNR Am J Neuroradiol* 2007; 28(1):38-41.
44. Whitlow CT, Mussat-Whitlow BJ, Mattern CW et al. Sacroplasty versus vertebroplasty: comparable clinical outcomes for the treatment of fracture-related pain. *AJNR Am J Neuroradiol* 2007; 28(7):1266-70.
45. Kamel EM, Binaghi S, Guntern D et al. Outcome of long-axis percutaneous sacroplasty for the treatment of sacral insufficiency fractures. *Eur Radiol* 2009.
46. Frey ME, Depalma MJ, Cifu DX et al. Percutaneous sacroplasty for osteoporotic sacral insufficiency fractures: a prospective, multicenter, observational pilot study. *Spine J* 2008; 8(2):367-73.
47. Zaman FM, Frey M, Slipman CW. Sacral stress fractures. *Curr Sports Med Rep* 2006; 5(1):37-43.
48. Denis F, Davis S, Comfort T. Sacral fractures: an important problem. Retrospective analysis of 236 cases. *Clin Orthop Relat Res* 1988; 227:67-81.
49. Furstenberg CH, Grieser T, Wiedenhofer B et al. The role of kyphoplasty in the management of osteogenesis imperfecta: risk or benefit? *Eur Spine J* 2010; 19 Suppl 2:S144-8.
50. Ma R, Chow R, Shen FH. Kummell's disease: delayed post-traumatic osteonecrosis of the vertebral body. *Eur Spine J* 2010; 19(7):1065-70.
51. Jensen ME, McGraw JK, Cardella JF et al. Position statement on percutaneous vertebral augmentation: a consensus statement developed by the American Society of Interventional and Therapeutic Neuroradiology, Society of Interventional Radiology, American Association of Neurological Surgeons/Congress of Neurological Surgeons, and American Society of Spine Radiology. *J Vasc Interv Radiol* 2007; 18(3):325-30.
52. American College of Radiology. Practice guideline for the performance of percutaneous vertebroplasty. 2006. Available online at: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/dx/head-neck/percutaneous_vertebroplasty.aspx. Last accessed July 2008.
53. Saad WE, Funaki BS, Ray CE et al. ACR Appropriateness Criteria management of vertebral compression fractures. 2010. Available online at: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria/pdf/ExpertPanelOnInterventionalRadiology/Management-of-Vertebral-Compression-Fractures.aspx. Last accessed January 2012.
54. McGraw JK, Cardella J, Barr JD et al. Society of Interventional Radiology quality improvement guidelines for percutaneous vertebroplasty. *J Vasc Interv Radiol* 2003; 14(9 Pt 2):S311-5.
55. Rosen, Hillel N. *Clinical manifestations and treatment of osteoporotic thoracolumbar vertebral compression fractures*. 2012. UpToDate. Available online: http://www.uptodate.com/contents/clinical-manifestations-and-treatment-of-osteoporotic-thoracolumbar-vertebral-compression-fractures?source=search_result&search=manifestations+and+treatment+of+osteoporotic+thoracolumbar+vertebral+compression+fractures&selectedTitle=1%7E150. Last accessed January 2013.

Percutaneous Kyphoplasty

56. 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* 2009; 373(9668):1016-24.
57. 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* 2011; 26(7):1627-37.

58. 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* 2011; 12(3):225-35.
59. 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* 2011; 26(7):1617-26.
60. Jarvik JG, Deyo RA. Cementing the evidence: time for a randomized trial of vertebroplasty. *AJNR Am J Neuroradiol* 2000; 21(8):1373-4.
61. Moerman DE, Jonas WB. Deconstructing the placebo effect and finding the meaning response. *Ann Intern Med* 2002; 136(6):471-6.
62. Hrobjartsson A, Gotzsche PC. Is the placebo powerless? An analysis of clinical trials comparing placebo with no treatment. *N Engl J Med* 2001; 344(21):1594-602.
63. Vase L, Riley JL, 3rd, Price DD. A comparison of placebo effects in clinical analgesic trials versus studies of placebo analgesia. *Pain* 2002; 99(3):443-52.
64. Buchbinder R, Osborne RH, Ebeling PR et al. A randomized trial of vertebroplasty for painful osteoporotic vertebral fractures. *N Engl J Med* 2009; 361(6):557-68.
65. Kallmes DF, Comstock BA, Heagerty PJ et al. A randomized trial of vertebroplasty for osteoporotic spinal fractures. *N Engl J Med* 2009; 361(6):569-79.
66. Blue Cross Blue Shield Association Technology Evaluation Center (TEC). Special Report: measuring and reporting pain outcomes in randomized controlled trials TEC Assessments 2006; Volume 21, Tab 11
67. Dudeney S, Lieberman IH, Reinhardt MK et al. Kyphoplasty in the treatment of osteolytic vertebral compression fractures as a result of multiple myeloma. *J Clin Oncol* 2002; 20(9):2382-7.
68. Journey DR, Schomer DF, Nader R et al. Percutaneous vertebroplasty and kyphoplasty for painful vertebral body fractures in cancer patients. *J Neurosurg* 2003; 98(1 Suppl):21-30.
69. Lane JM, Hong R, Koob J et al. Kyphoplasty enhances function and structural alignment in multiple myeloma. *Clin Orthop Relat Res* 2004; (426):49-53.
70. Official Disability Guidelines, Integrated Treatment / Disability Duration Guidelines, Low Back-Lumber & Thoracic (Acute & Chronic), Vertebroplasty (updated 05/10/13). <http://www.odg-twc.com/> - Accessed July 2013.

Other References

1. Blue Cross and Blue Shield of Kansas National Consultant, Practicing Board Certified Orthopedic Surgeon (241), September 2008.
2. Blue Cross and Blue Shield of Kansas National Consultant, Practicing Board Certified Interventional Radiologist (470), December 2008.
3. Blue Cross and Blue Shield of Kansas Family Practice Liaison Committee CB, May 2009.
4. Blue Cross and Blue Shield of Kansas Orthopedic Liaison Committee CB, May 2009.
5. Blue Cross and Blue Shield of Kansas Radiology Liaison Committee CB, May 2009.
6. Blue Cross and Blue Shield of Kansas Radiology Liaison Committee, February 2013.
7. Blue Cross and Blue Shield of Kansas Orthopedic Liaison Committee, February 2013.
8. Blue Cross and Blue Shield of Kansas Family Practice Liaison Committee, July 2013.