Percutaneous vertebroplasty and kyphoplasty for painful vertebral body fractures in cancer patients

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Object. The current North American experience with minimally invasive vertebro- and kyphoplasty is largely limited to the treatment of benign osteoporotic compression fractures. The objective of this study was to assess the safety and efficacy of these procedures for painful vertebral body (VB) fractures in cancer patients.

Methods. The authors reviewed a consecutive group of cancer patients (21 with myeloma and 35 with other primary malignancies) undergoing vertebro- and kyphoplasty at their institution. Ninety-seven (65 vertebro- and 32 kyphoplasty) procedures were performed in 56 patients during 58 treatment sessions. The mean patient age was 62 years (± 13 years [standard deviation]) and the median duration of symptoms was 3.2 months. All patients suffered intractable spinal pain secondary to VB fractures.

Patients noted marked or complete pain relief after 49 procedures (84%), and no change after five procedures (9%); early postoperative Visual Analog Scale (VAS) pain scores were unavailable in four patients (7%). No patient was worse after treatment. Reductions in VAS pain scores remained significant up to 1 year (p = 0.02, Wilcoxon signed-rank test). Analgesic consumption was reduced at 1 month (p = 0.03, Wilcoxon signed-rank test). Median follow-up length was 4.5 months (range 1 day–19.7 months). Asymptomatic cement leakage occurred during vertebroplasty at six (9.2%) of 65 levels; no cement extravasation was seen during kyphoplasty. There were no deaths or complications related to the procedures. The mean percentage of restored VB height by kyphoplasty was 42 ± 21%.

Conclusions. Percutaneous vertebro- and kyphoplasty provided significant pain relief in a high percentage of patients, and this appeared durable over time. The absence of cement leakage–related complications may reflect the use of 1) high-viscosity cement; 2) kyphoplasty in selected cases; and 3) relatively small 3volume injection. Precise indications for these techniques are evolving; however, they are safe and feasible in well-selected patients with refractory spinal pain due to myeloma bone disease or metastases.

Key Words • fracture • bone cement • vertebroplasty • kyphoplasty • myeloma • metastasis

Destructive vertebral lesions are a common source of morbidity in patients with metastatic disease and multiple myeloma. Approximately 30% of patients with various neoplastic conditions develop symptomatic spinal metastases during the course of their illness,2,26 and pain is the presenting complaint in the majority of cases.12,27

Nonoperative treatments include analgesic medication and radiotherapy. In cases of certain tumor types, hormone therapy, cytotoxic drugs, and bisphosphonates are increasingly used.31 None of these modalities is uniformly effective in relieving pain or improving ambulatory status. Surgical management generally involves vertebrectomy, reconstruction with a cage or PMMA bone cement, and stabilization with pedicle screws.7 Surgical procedures require a significant postoperative recovery period and have associated morbidity and mortality in patients who often have limited life expectancy. In addition, surgery is rarely used to treat patients with multifocal spinal disease.

Developed in France in the late 1980s, minimally invasive vertebroplasty involves the percutaneous injection of PMMA into a fractured VB. Although this does not reexpand a collapsed vertebra, reinforcing and stabilizing the fracture seems to alleviate pain. The procedure was first used to treat aggressive vertebral hemangiomas8 and was later applied to other lesions that weaken the VB, including osteolytic metastases9,10,13,16 and osteoporotic VB collapse.2,12,10,13

Although the European experience with vertebroplasty in the setting of spinal metastases and myeloma is more extensive,2,10,13,16,18,24 the indications for treatment among most North American series are currently heavily weighted toward osteoporotic bone disease.12,10,13

Procedural complications are relatively rare; however,
most are related to leakage of PMMA through cortical defects, with epidural compression of the neural elements.\textsuperscript{20}

Percutaneous balloon kyphoplasty, a recent modification of vertebroplasty, involves inflation of a balloon within a collapsed VB to restore height and reduce kyphotic deformity, prior to stabilization with PMMA.\textsuperscript{11,15,23} The risk of cement extravasation is theoretically reduced because inflation of the balloon creates a void within the VB into which cement can be injected under relatively low pressure.

The objective of this study was to assess the safety and efficacy of vertebro- and kyphoplasty in the treatment of painful VB fractures in cancer patients. To our knowledge, this report represents the largest series for both of these procedures in the cancer setting.

**Clinical Material and Methods**

We performed a retrospective review of all patients who underwent percutaneous vertebro- or kyphoplasty at The University of Texas M. D. Anderson Cancer Center between October 2000 and February 2002. Five patients in whom there was no diagnosis of cancer (four with osteoporotic compression fractures and one with a T-6 hemangioma) were excluded.

**Patient Population**

The study population included 56 patients, 31 men (55\%) and 25 women (45\%), whose median age was 64 years (range 30–82 years).

Demographic data, duration of symptoms, indications for treatment, primary tumor site, location of disease in the spine, and treatment history (spinal surgery, vertebroplasty, kyphoplasty, spinal radiotherapy, and chemotherapy) were recorded. A multidisciplinary team of physicians consisting of a neurosurgical or orthopedic spine surgeon and a radiation and/or medical oncologist evaluated all patients. In almost every case, pain management and rehabilitation medicine specialists were also involved. Neurological status was evaluated using the classification system described by Frankel, et al.\textsuperscript{8} A VAS\textsuperscript{22} was used to measure pain status. We also evaluated the use of pain medication, as outlined in Table 1. All patients underwent plain radiography and MR imaging of the spine. In some cases, CT scanning and radionuclide bone scanning were also performed.

Details of the procedures, postoperative course, length of stay, and complications were reviewed. Verteoplasty and kyphoplasty were performed by radiologists (D.F.S. or K.A.); however, patient evaluations (within 24 hours postoperatively, at 1 month after surgery, at 3-month intervals for the 1st year, and approximately every 6 months thereafter) were performed by the spine surgeon. All patients underwent posttreatment plain radiography. Additional imaging studies were performed if treatment failed to relieve pain, for relapse of pain, or if there was a change in neurological status. The length of follow-up review was calculated from the date of procedure to the most recent clinic visit or death.

**Treatment Indications**

A treatment algorithm for VB fractures in cancer patients is provided in Fig. 1.

\begin{table}[h]
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\begin{tabular}{|c|c|}
\hline
\textbf{Category} & \textbf{Medication} \\
\hline
1 & none \\
2 & acetaminophen, nonsteroidal antiinflammatory medication \\
3 & codeine, hydrocodone, oxycodone, propoxyphene hydrochloride \\
4 & morphine SR/IR, fentanyl TD, oxycodone SR/IR \\
5 & intravenous narcotic agent \\
\hline
\end{tabular}
\caption{Classes of analgesic medications used in patients who underwent vertebro- and/or kyphoplasty*}
\end{table}

*IR = intermediate release; SR = slow release; TD = transdermal.

A diagnosis of cancer and disabling pain secondary to pathological thoracic or lumbar VB fractures was established in all patients. Severe pain also limited the ambulatory capacity of some patients. Conservative therapy consisting of analgesic medication, bed rest, and in some cases external brace therapy had failed in all patients. Many were also considered poor surgical candidates because of comorbid medical illnesses or multilevel spinal disease. Contraindications included epidural compression of the neural elements; failure to localize symptomatic level(s); pain that was predominantly radicular in nature; and significant medical contraindications such as uncorrected coagulopathy, local infection at the planned injection site, or intolerance to being positioned prone. Informed consent was obtained from all patients.

Several relative factors determined whether vertebro- or kyphoplasty was performed at a given symptomatic level. Kyphoplasty was favored in the presence of 1) kyphosis that was deemed to contribute significantly to morbidity (that is, a deformity $\geq 20^\circ$); and 2) disruption of the posterior vertebral cortex, where more controlled delivery of bone cement was desired. In patients with significant vertebral collapse (vertebra plana), kyphoplasty was preferred to restore height; however, vertebroplasty was performed when the collapse was too severe to permit insertion of the balloon device. Finally, vertebroplasty was
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performed if the patient could not tolerate general anesthesia or the relatively longer procedure time required for kyphoplasty.

Vertebroplasty Technique

Vertebroplasty was performed under biplane fluoroscopy in the neurointerventional angiography suite, involving the same sterile protocols as used in operating rooms. At the discretion of the anesthesiologist, the procedure was performed after induction of general anesthesia or after administration of a local anesthetic combined with intravenous narcotic or sedative drugs. Patients were positioned prone with horizontal rolls placed under the chest and pelvis.

The needle entry site over the pedicle was localized in the AP plane. The skin entry site, the underlying subcutaneous tissue, and the periosteum were infiltrated with a 50/50 mixture of 1% lidocaine and 0.25% bupivacaine. A 13-gauge needle (Osteo-Site bone biopsy needle; Cook, Inc., Bloomington, IN) was introduced through a small dermatotomy and advanced to the posterior aspect of each pedicle along its superolateral cortex. The bevel of the needle was directed so that the tip pointed laterally, to avoid penetration of the spinal canal. The needle was directed anteriorly, medially, and caudally through the pedicle to reach a point within the anterior third of the VB, near the midline in the sagittal plane (Fig. 2). Within the VB, the tip was directed medially—the optimal orientation for PMMA delivery to the VB. When the diagnosis was uncertain, a 16-gauge needle (Franseen; Cook, Inc.) was introduced coaxially to obtain biopsy samples.

We combined 40 ml of the PMMA powder (Simplex P; Stryker-Howmedica-Osteonics, Rutherford, NJ) with 6 g of sterile barium sulfate powder (Bryan; Woburn, MA) for opacification and 1 g of powdered tobramycin (Nebcin; Eli Lilly, Indianapolis, IN) for antibiotic prophylaxis prior to adding the 10 ml of liquid monomer. The preparation was mixed until a doughy, cohesive consistency (similar to toothpaste) was obtained.

Multiple 1-ml syringes were filled with the cement mixture and injected into the interstices of the VB under constant fluoroscopic control. The objective was to fill the anterior two thirds of the VB as visualized on the lateral projection (Figs. 3 and 4). If PMMA filled less than 50% of the VB, contralateral cannulation and injection was performed. Total injection volumes ranged from 2 to 8 ml.

When extravasation of cement beyond the confines of the VB was visualized, the procedure was usually terminated and a CT scan was obtained. In some cases, we were able to prevent further leakage by adjusting the needle.
position or by performing the injection through the contralateral pedicle.

At the completion of vertebroplasty, the needle was withdrawn, the puncture site closed with steri strips, and a sterile dressing applied. Patients were kept in bed for a minimum of 1 hour to allow the cement to polymerize fully.

**Kyphoplasty Technique**

Kyphoplasty was always performed with the patient in the prone position after induction of general anesthesia; biplane fluoroscopic guidance was used in all cases. Bilateral access to the VB was uniformly obtained. The procedure is depicted, step-by-step, in Fig. 5. Thirteen-gauge needles were advanced through the pedicles as for vertebroplasty (Fig. 2); however, the endpoint was within the posterior one third of the VB. A series of instruments were used to create two working channels (Fig. 5). A hand-mounted drill was used to create bilateral channels within

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**Fig. 4.** Imaging studies revealing L-2 and L-3 disease in a patient with lung cancer metastases. The PMMA was purposefully injected only on the right side at L-2 to avoid cement leakage from osteolytic disruption of the left posterior VB cortex (see upper right). Left and Center: The final cement casting is shown on AP (left) and lateral (center) fluoroscopic images. Upper and Lower Right: Axial CT scans (L-2 [upper]; L-3 [lower]) also demonstrating final casting.

**Fig. 5.** Artist’s rendering of the kyphoplasty technique. Using a bilateral transpedicular approach, bone biopsy needles are directed into the posterior third of the VB. Guide pins (K-wires) are used to exchange the biopsy needles for blunt cannulated obturators (1). Working cannulas (2) are then advanced, and the obturators and K-wires are removed. A hand-mounted drill (3) creates bilateral channels within the anterior aspect of the VB for placement of the IBTs (4). Balloon inflation allows restoration of VB height. Inset: The IBTs are removed and the osseous void is filled with PMMA displaced from bone cement cannulae (5).
the anterior aspect of the VB for placement of the IBTs (Kyphon, Inc., Sunnyvale, CA).

The IBT is a high-pressure balloon designed to reduce the VB back to its original height by creating a cavity that is subsequently filled with the PMMA (Fig. 6). The IBTs are available in lengths of 15 and 20 mm (maximum volume of 4 and 6 ml, respectively) and are selected according to the AP diameter of the VB. The IBT is ideally centered between the collapsed endplates in the anterior two thirds of the VB. There are two radiopaque markers that identify the balloon for accurate placement (Fig. 7). Balloon inflation was performed under strict lateral fluoroscopic control, and the inflation pressure was monitored via an in-line pressure gauge. Inflation endpoints were: 1) fracture reduction; 2) contact of the balloon with any cortical surfaces; or 3) attaining the maximum inflation pressure of 220 psi.

The PMMA preparation was the same as that for vertebroplasty. Specialized bone cement cannulas were filled with the PMMA preparation. The IBTs were deflated and exchanged for the cement cannulas. A stylet, which acts as a plunger, displaces the cement into the VB. Filling was stopped once the void left by the IBT was filled and the PMMA was observed to extend out into the trabecular spaces. The volume applied was typically 1 to 2 ml greater than the final inflation volume, because of interdigitation of PMMA into the surrounding cancellous bone. The puncture wounds were closed with steri strips, sterile dressings were applied, and the patient was placed in the supine position for the duration of the recovery.

Assessment of Restored Height and Kyphosis Correction by Kyphoplasty

Assessments of restored VB height were performed as described by Lieberman, et al.\textsuperscript{15} The vertical height (endplate to endplate) at the center of the VB on lateral radiographs was measured before and after kyphoplasty. The vertebra above the fracture was also measured as an estimate of prefracture height. Calculations included the following: height regained = posttreatment height – pretreatment fractured height; height lost = estimated prefracture height – pretreatment fractured height; percentage of restored lost height = (height regained/height lost) \times 100.

Local kyphosis was assessed on the lateral radiographs by measuring the angle obtained by a line parallel to the inferior endplate of the fractured vertebra and that of the vertebra one level above, as shown in Fig. 8.

Results

Patient Characteristics

The most frequent tumor type was multiple myeloma (21 of 56; Table 2). The median follow-up duration was 4.5 months (range 1 day–19.7 months). The numbers of patients available for evaluation at each follow-up interval were 41 (73%) at 1 month; 37 (66%) at 3 months; 21 (38%) at 6 months; and eight (14%) at 1 year. One patient died during the follow-up period (2.5 months after vertebroplasty).

The median duration of spinal pain was 3.2 months...
(range 1 week–26 months); the precise chronology of pain was difficult to determine in some patients. Neurological deficits were limited to minor sensory complaints in two patients; however, because of severe pain, 13 patients (23%) were ambulating with assistive devices such as a cane or walker and two patients (4%) were essentially wheelchair bound.

In many patients multiple levels of VB collapse or end-plate fracture were demonstrated on radiography and MR imaging. On a review of preprocedural neuroimaging reports, the median number of compressed VBs for the entire study population was two (range zero–nine). Symptomatic levels were identified by correlating the clinical data with imaging findings (see Treatment Indications).

Several patients had risk factors for osteoporosis (advanced age, postmenopausal status, chronic corticosteroid use, and medically debilitated state), and it was often difficult to determine the extent to which this was responsible for VB collapse compared with a purely osteolytic malignant process. Tumor enhancement with gadolinium on MR imaging studies, or what appeared to be osteolysis secondary to multiple myeloma, was demonstrated in 42 patients (75%). In three patients coaxial transpedicular biopsy samples of vertebral lesions were acquired during vertebroplasty, and in all of these cases metastatic disease from a known primary tumor was confirmed.

Many patients had undergone previous therapy for spinal disease (Table 2). Forty-seven patients (84%) received some form of chemotherapy (hormonal or cytotoxic). Eighteen patients (32%) had undergone spinal radiotherapy. Seven patients (13%) had undergone invasive spinal procedures: vertebroplasty at another institution in one and spinal operations in six. Surgery had been performed the level of a subsequent vertebroplasty in only one patient.

Ninety-seven (65 vertebroplasty and 32 kyphoplasty) procedures were performed in 56 patients during 58 treatment sessions. Thirty-four patients (61%) underwent vertebroplasty, 15 (27%) kyphoplasty, and seven (13%) underwent both procedures at separate levels. The mean number of spinal levels treated per session was 1.7 (range one–five). The thoracolumbar junction was the most common level treated (Fig. 9).

Although kyphoplasty was routinely performed after induction of general anesthesia, 16 (46%) of 35 treatment sessions for vertebroplasty were performed after administration of a local anesthetic.

A transpedicular approach to the VB was preferred; destruction of the pedicle necessitated an extrapedicular approach during three vertebro- and two kyphoplasty procedures. For kyphoplasty, bilateral vertebral body access was performed in all cases. For vertebroplasty, significant cross filling of the VB allowed a unilateral approach in 42 (65%) of 65 procedures.

Postoperatively, most patients were transferred to the same-day surgery unit. Patients were discharged on the same day in 22 treatment sessions (38%), and within 24 hours in 26 treatment sessions (45%). Four patients in whom a treatment-related immediate analgesic effect did not occur subsequently improved and were discharged within 3 days. The remaining six treatment sessions were for inpatients admitted prior to the procedures because of severe back pain. The median length of stay for the entire study population, and among each of the treatment groups, was 1 day.
Vertebral Body Height and Kyphosis Correction

The following values are presented as the mean ± standard deviation. The mean vertebral height lost prior to kyphoplasty was 9.7 ± 5.1 mm. The mean height regained by the procedure was 4.5 ± 3.6 mm. The differences achieved statistical significance (p = 0.01, Student paired t-test). The mean percentage of vertebral height lost that was restored by kyphoplasty was 42 ± 21%.

The mean local kyphosis, measured from fluoroscopic images obtained during kyphoplasty was 25.7 ± 9.7°. After the procedure, the mean kyphosis measured 20.5 ± 8.7° (p = 0.001, Student paired t-test). Mean improvement in local kyphosis was 4.1 ± 3.72°.

Complications and Relapse of Pain

There were no deaths within 30 days and no complications related to the procedures. One patient was readmitted to the hospital 15 days after kyphoplasty for an exacerbation of preexisting congestive heart failure. A patient with metastatic esthesioneuroblasoma developed sudden paraplegia 13 days after an L-1 vertebraloplasty secondary to a progressive T-8 epidural metastasis.

Extrusion of PMMA beyond the confines of the VB was observed at six levels. All of these events occurred during vertebroplasty (six [9.2%] of the 65 vertebroplasty procedures). In all cases, leakage was noted on fluoroscopy during PMMA injection and CT scanning was performed immediately after the procedure. Cement extruded through a fractured endplate into the adjacent disc space in five cases. Extravasation of PMMA into the anterior perivertebral soft tissues occurred in one case, an L-3 vertebroplas-

![Fig. 9. Bar graph demonstrating the distribution frequency of the spinal levels treated by vertebro- or kyphoplasty.](image-url)

TABLE 3

| Pain outcome after 58 treatment sessions involving vertebro- and/or kyphoplasty* |
|---------------------------------|---------|---------|---------|
| VP & KP | 8 (23) | 3 (38) | 12 (21) |
| KP     | 22 (63) | 4 (50) | 37 (64) |
| VP     | 3 (9) | 1 (13) | 5 (9) |
| worse  | 15 (26) | 8 (14) | 58 |

* Results refer to an analysis of documented VAS pain scores within the first 24 hours. Multiple results during that period were averaged.
ty. There were no incidents of cement leakage into the epidural space or neural foramen. All cement leaks were asymptomatic—there were no radicular complaints or neurological deficits as a result of cement extrusion.

There were no delayed complications as a result of vertebro- or kyphoplasty. Over the subsequent weeks or months several patients developed recurrent pain as a result of osteolytic disease or vertebral collapse at other levels. Radiography and MR imaging did not reveal additional compression or change in the pattern of the PMMA.

Two patients underwent repeated vertebro- or kyphoplasty for symptomatic osteolytic VB fractures at new levels—in both patients, multiple myeloma was the primary diagnosis. Two patients, both with lymphoma and multiple symptomatic levels of disease, eventually received spinal intrathecal morphine infusion pumps for persistent pain.

Two patients underwent subsequent spinal surgery. The first was a 71-year-old woman with thoracolumbar osteolytic disease and kyphosis secondary to multiple myeloma. Her initial analgesic response to T-11 kyphoplasty and T-12 vertebroplasty was good; however, the procedure left her kyphosis largely unchanged, and within 2 months she experienced recurrent pain. She underwent T-11 and T-12 vertebrectomy via a thoracoabdominal approach, and a separately staged posterior instrumentation-assisted fusion of T-6 through L-3 involving placement of pedicle screws and allograft. The second patient was an 82-year-old man with prostate cancer and an L-4 compression fracture who underwent vertebroplasty with good initial success. Within 2 months, his low-back pain returned and he developed new radicular pain involving the left leg. No neurological deficits were demonstrated. Plain radiography and CT scanning revealed the PMMA in good position and no evidence of extravasation or dislodgment. Magnetic resonance imaging demonstrated a combination of foraminal stenosis and neural encroachment by progressive epidural disease. The patient underwent two separately staged procedures: an L-4 vertebrectomy via a retroperitoneal approach as well as posterior decompression and L3–5 instrumentation-assisted fusion.

Five patients underwent spinal radiotherapy after vertebro- or kyphoplasty without incident.

**Discussion**

The results obtained in this series indicate that, in selected cancer patients with VB fractures, vertebro- and kyphoplasty are well-tolerated procedures associated with early clinical improvement of pain. For the entire study population, there was a significant decrease in analgesic

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**TABLE 4**

*The medication categories are described in Table 1.*

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*Fig. 10. Bar graph showing pre- and postoperative median VAS scores in 56 patients who underwent vertebroplasty, kyphoplasty, both procedures, and all patients. A score of 10 indicates severe pain and a score of 0 indicates no pain. All results were significant (p < 0.05, Wilcoxon signed-rank test), except where indicated by an asterisk.*

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usage at 1 month, and the VAS pain scores reflected durable analgesic effects at each follow-up interval to 1 year. Lack of pain relief was mostly observed in a few patients with advanced-stage disease. There were no early or delayed symptomatic complications as a result of the procedures.

Although there may be much debate in the near future regarding the relative risks, benefits, and costs of vertebro- compared with kyphoplasty, the purpose of this study was not to compare the two. Such an analysis based on an uncontrolled series with retrospectively acquired data would be complex and misleading; selection criteria for the two procedures differed. Rather, we emphasized pain control, neurological outcome, complications, and durability of vertebral- and kyphoplasty in a unique patient population. We agree that kyphoplasty may be differentiated from vertebroplasty on the basis of VB height restoration and, perhaps, risk of cement extravasation. Whether the additional complexity and cost of kyphoplasty are offset by these potential benefits, however, will only be borne out in long-term prospective randomized studies.

Vertebroplasty Procedures

To our knowledge, there are only two series in the English-language literature in which investigators specifically address the use of percutaneous vertebroplasty in patients with osteolytic metastases and myeloma; both are from French institutions. Weill, et al.,24 reported a retrospective series of 37 patients who underwent 52 vertebroplasty procedures for spinal metastases. Twenty-four (73%) of 33 treatment sessions performed for pain relief resulted in “clear improvement.” Three patients had transient radiculopathy due to cement extrusion; surgical removal of epidural cement in the neural foramen was required in one patient. In the same year, Cotton, et al.,5 reported prospectively acquired data obtained in 37 patients who underwent 40 vertebroplasty procedures for osteolytic metastases (29 patients) and myeloma (eight patients). Partial or complete pain relief was observed after 36 (97%) of 37 procedures. Extravasation of bone cement occurred in 29 of 40 injections; most of these patients were asymptomatic, but two required decompressive surgery.

Among North American centers, the published experience with vertebroplasty is largely limited to the setting of osteoporotic compression fractures.1,2,10,13 In these series, the largest number of vertebroplasty-treated patients with nonosteoporotic benign or malignant vertebral destructive lesions treated was eight.2

In the present study, in patients who underwent vertebro- without kyphoplasty, outcomes were similar to those in the literature. Complete pain relief or improvement occurred after 30 (86%) of 35 treatment sessions (Table 3). Median VAS scores were significantly reduced at each follow-up interval to 6 months (Fig. 9); however, results at 1 year did not reach statistical significance because of the small numbers of patients.

The rate of cement leakage (9.2% in vertebroplasty procedures) compares favorably with published rates.1,2,6,10,13,14,24 Cement leakage is reported to occur during as many as 73% of vertebroplasty procedures.3 Most cases are asymptomatic, including those in the present series.

Many authors advocate the use of vertebral phlebography prior to cement injection to 1) identify potential sites of epidural leakage and 2) evaluate for brisk filling of anastomotic venous channels, which may increase the risk of pulmonary embolization with bone cement.1,5,16,24 Although vertebral venography demonstrates the perivertebral venous drainage, it does not reliably predict the final casting of cement because the viscosity of the contrast media and the cement are not comparable.6 In addition, particularly for tumors with necrotic cavities, postphlebography contrast residues may be difficult to wash out and may interfere with fluoroscopic control during cement injection. In agreement with Deramond, et al.,5 we only perform vertebralplasty phlebography in cases of vertebral hemangiomas.

Three factors may have accounted for the relatively low rate of cement leakage in this series. First, we chose a type of PMMA that polymerizes rapidly. Insufficient polymerization has been implicated as a major risk factor for pulmonary embolization of acrylic cement, which in some series has been fatal.19 We did not inject cement until it had achieved a very cohesive, doughy texture. Second, the injection volumes were relatively small (range 2–8 ml). Some authors have correlated complications with excessive PMMA injection,16 whereas others have found no association.5 On the other hand, the amount of lesion filling has not been shown to correlate with the degree of pain reduction.5 Additionally, in an ex vivo biomechanical study involving osteoporotic cadaveric VBs with experimentally induced compression fractures, strength was restored to all regions of the spine when as little as 2 ml of cement was injected.1 Thus, we found no justification in the literature for large injection volumes. Third, kyphoplasty was performed in selected cases with cortical defects of the posterior vertebral wall. Extravasation of cement is theoretically less likely to occur during kyphoplasty because injections are performed under relatively low pressures into a preformed cavity within the bone.15

Kyphoplasty Procedures

In patients treated with kyphoplasty without vertebroplasty, pain was completely relieved or improved after 12 (80%) of 15 treatment sessions (Table 3). The VAS scores indicated significant pain reduction at each follow-up interval to 1 year (Fig. 10). Outcomes were similar in patients who underwent an additional eight treatment sessions involving both kypho- and vertebroplasty.

Although the kyphoplasty device has attained the approval of the Food and Drug Administration, we are aware of only two studies that document its indications, efficacy, and complication profile in humans.15,22 In both studies, the procedure was conducted only in patients with osteoporotic compression fractures. The prospective series of 30 patients by Lieberman, et al.,15 however, included six patients with multiple myeloma.

In the present series, there were no local complications resulting from kyphoplasty. Neither cement leakage nor IBT rupture occurred during any of the procedures.

We found significant improvement in postkyphoplasty VB height and local kyphosis. The radiographic method, involving plain lateral x-ray films, for detecting height restoration and deformity correction was similar to published reports.15,23 Admittedly, this method does not account for the spinal deformity as a whole. We agree with
Lieberman, et al.,15 that pre- and postoperative 3-ft standing lateral radiographs would best measure changes in kyphosis and VB height. In future prospective studies at our center we will incorporate such measures.

Conclusions
Current nonsurgical treatment options for malignant spinal disease include analgesic medication, radiotherapy, hormone therapy, cytotoxic drugs, embolization, and bisphosphonates.21 Vertebroplasty and kyphoplasty represent important additions to this therapeutic arsenal. A multidisciplinary approach to patient selection and management is essential. Precise indications for each of these techniques are evolving; however, kyphoplasty has the added advantage of addressing spinal deformity and appears to be associated with fewer instances of bone cement extravasation. A full understanding of the risks and benefits of vertebro- and kyphoplasty will require randomized clinical trials.

References

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