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Vertebroplasty for Osteoporotic Fractures with Spinal Canal Compromise

BACKGROUND AND PURPOSE: Percutaneous vertebroplasty can aggravate spinal canal narrowing, especially in patients with preoperative retropulsion. The purpose of this study was to evaluate changes in spinal canal dimension during percutaneous vertebroplasty for osteoporotic fractures with retropulsion.

MATERIALS AND METHODS: We reviewed all cases of osteoporotic vertebral fractures treated with vertebroplasty. Twenty-one patients (25 vertebrae) had a retropulsed fragment that compromised the dimension of the spinal canal on preoperative imaging. We measured the degree of retropulsion before and after vertebroplasty to evaluate changes in spinal canal dimension. We also evaluated pain, neurologic status, vertebral body height, and wedge angle.

RESULTS: Mean retropulsion was 4.2 mm before and 4.4 mm after vertebroplasty. There was no statistically significant difference ($P = .32$). Mean increase in vertebral body height was 2.6 mm anteriorly, 1.7 mm centrally, and 0.3 mm posteriorly. Mean decrease in wedge angle was 4.7°. There were statistically significant improvements in height and wedge angle ($P < .01$). None of our patients developed new symptoms during vertebroplasty or thereafter. Twenty of 21 patients (95%) showed partial or complete immediate pain relief, whereas 1 patient did not improve.

CONCLUSION: Vertebroplasty can be performed safely in patients with spinal canal compromise. This procedure can reduce pain, increase vertebral body height, and decrease wedge angle without worsening of retropulsion.

Percutaneous vertebroplasty is a minimally invasive procedure to relieve or decrease pain in patients with osteoporotic compression fractures who have failed conservative management.[1-12] Spinal canal narrowing due to a retropulsed fragment has been considered one of the contraindications for vertebroplasty because of a risk of further spinal canal compromise.[12-14] Earlier investigations have evaluated morphologic changes after vertebroplasty, such as increase in vertebral body height and change in wedge angle.[2-7] However, to our knowledge, there are no previous studies with quantitative evaluation of retropulsion in patients with spinal canal compromise. We have successfully performed vertebroplasty in patients with retropulsed fragments. The purpose of this study was to review our experience with vertebroplasty in patients with retropulsion and to evaluate morphologic changes during the procedure.

Materials and Methods

Our institutional review board approved this study and waived the requirement of informed consent. The study was compliant with the regulations of the Health Insurance Portability and Accountability Act.

Patients

In our institution, vertebroplasty was performed in patients who failed conservative treatment and were not candidates for surgery because of age, severe osteoporosis, or debilitation. Exclusion criteria included radicular symptoms, unstable fractures involving the posterior column, or cord compression. We reviewed all 55 patients with 139 osteoporotic compression fractures treated with vertebroplasty and selected all those who had spinal canal compromise due to retropulsion. This study was based on 21 patients (12 women and 9 men; age range, 51–93 years; mean age, 79 years) in whom preoperative imaging showed retropulsion. We analyzed 25 vertebral bodies in these 21 patients. Most of the fractures were around the thoracolumbar junction. The locations and numbers of the treated vertebrae were as follows: T4 ($n = 1$), T5 ($n = 1$), T6 ($n = 1$), T7 ($n = 1$), T8 ($n = 1$), T10 ($n = 2$), T11 ($n = 1$), T12 ($n = 5$), L1 ($n = 4$), L2 ($n = 5$), L3 ($n = 1$), and L4 ($n = 2$).

Vertebroplasty Technique

Vertebroplasty was performed through a transpedicular or parapedicular approach by using 13-gauge bone-biopsy needles (Osteo-Site, Cook, Bloomington, Ind) placed into the anterior one third of the vertebral body. The procedure was performed under biplane fluoroscopic control with use of conscious sedation and local anesthetic on an outpatient basis.

The patient lay prone on the angiographic table. Once the needle or needles were placed in the vertebral body, the liquid and powder polymethylmethacrylate (Cranioplastic; Codman, Raynham, Mass) was mixed with 12 g of barium sulfate to a doughlike consistency. The cement was thicker than toothpaste and relatively hard to inject through the 13-gauge needle by using a 1-mL syringe. However, this was not an "extra-thick" cement formulation. Under biplane fluoroscopic guidance, the cement was injected through the needles. The injection continued until the vertebral body was filled toward the posterior 25% or there was prominent leakage. Special attention was paid to worsening of retropulsion on fluoroscopy. After cement injection, the patient remained prone on the angiographic table for 15–30 minutes and was then transferred to a regular bed. The patient remained in bed until CT had been performed. The patients were evaluated for pain relief and presence of neurologic symptoms. Thereafter, the patients were discharged home as tolerated.
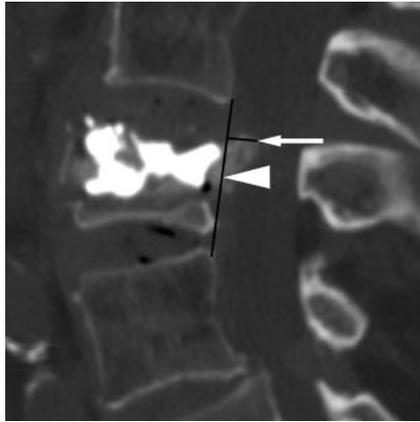
Fig 1. Lines used to measure retropulsion of the bone fragment over sagittal CT scans. Retropulsion is measured by using a distance from the line between the posterior margin of the adjacent vertebral bodies (*arrowhead*) and the bony fragment (*arrow*).

Imaging Technique

Eighteen patients underwent preoperative MR imaging. The other 3 patients underwent preoperative CT. MR imaging was performed with a 1.5T imager. At least sagittal T1-weighted (TR/TE, 500–767/8–22 ms), sagittal T2-weighted (TR/TE, 3800–4550/98–123.6 ms), and sagittal fat-suppressed contrast-enhanced T1-weighted (TR/TE, 567–750/8–23 ms) images were obtained. In some cases, additional sequences were also available. The patients were given an intravenous injection of 0.2 mmol/kg of gadodiamide. Typical imaging parameters were as follows: FOV, 34–36 × 25.5–36 cm; matrix size, 256–512 × 160–256; section thickness, 3 mm; intersection gap, 0.5–1 mm; and echo-train length, 1–4.

CT scans were obtained by using a single-detector or 4–detector row CT scanner with the following parameters: 0.625- to 3-mm collimation, 3.75- to 7.5-mm/s table speed, 16- to 24-cm FOV, 250–280 mAs, and 120 kVp. Reconstructions were performed at 2- to 3-mm section thickness.

The average duration between the preoperative imaging and treatment was 11 days (range, 0–40 days). All CT scans were obtained within 24 hours of completion of procedures.

Imaging Assessment

The raw CT and MR imaging data were transferred to a workstation. CT and MR images were shown with regular clinical window width and level settings. Sagittal reformatted images were created for CT. Vertebral body height was measured in the anterior, central, and posterior portions of the vertebra and wedge angle, in the midsagittal plane as previously described.[3,15] Retropulsion of the bone fragment was also measured in the same plane by using a distance from the line between the posterior margin of the adjacent vertebral bodies and the retropulsed bony fragment (Fig 1). Measurement was performed by using a magnified image to the nearest 0.1 mm and 1°, twice at the workstation, and the mean was recorded. One untreated vertebral body adjacent to the treated vertebral body was also measured as a control in each patient to evaluate the validity of our measurements.

Statistical Analysis

Statistical analysis was performed with commercially available software. The statistical significances of changes in retropulsion, vertebral body height, and wedge angle were evaluated with the Wilcoxon signed rank test for treated vertebral bodies. Control vertebral bodies

Mean retropulsions, vertebral heights, and wedge angles before and after vertebroplasty				
Parameter	Before Treatment	After Treatment	Difference	*P*
Retropulsion (mm)	4.2	4.4	0.2	.32
Anterior height (mm)	15.2	17.8	2.6	<.001
Central height (mm)	11.1	12.9	1.7	.001
Posterior height (mm)	21.9	22.3	0.3	.002
Wedge angle	12.4°	7.7°	−4.7°	<.001

were evaluated with the paired *t* test. A *P* value of less than .05 was considered statistically significant.

Results

Our results are summarized in the Table. Mean retropulsion of bony fragments was 4.2 mm before and 4.4 mm after vertebroplasty. This difference was not statistically significant (*P* = .32) (Fig 2). The largest change in retropulsion occurred in 1 patient at L3, where the retropulsion increased from 5.2 to 8.0 mm. This patient did not develop any new neurologic symptoms during vertebroplasty or thereafter.

Mean increase in vertebral body height was 2.6 mm anteriorly, 1.7 mm centrally, and 0.3 mm posteriorly. Mean decrease in wedge angle was 4.7°. There were statistically significant differences in height and wedge angle (*P* < .01).

None of the patients in this series developed new neurologic symptoms during or after vertebroplasty. Twenty of 21 patients (95%) showed partial or complete immediate pain relief. The other patient did not improve.

No control vertebral body showed a difference larger than 1.0 mm or 1.0°. No significant differences were noted in anterior (*P* = .90), central (*P* = .99), and posterior (*P* = .49) portions and wedge angle (*P* = .79) of the control vertebral bodies. The average pre- and postoperative vertebral body heights were the same: 25 mm anteriorly, 22 mm centrally, and 26 mm posteriorly. The average wedge angle was 2.6°.

Discussion

This retrospective study shows that vertebroplasty can be performed in patients with spinal canal narrowing without worsening of retropulsion or symptoms. This is in accordance with previous studies that have shown the safety of this procedure even in spinal canal compromise.[1,8-11,14,16] To the best of our knowledge, this is the first study with quantitative evaluation of retropulsion during vertebroplasty.

Because of the nature of the procedure, vertebroplasty carries a risk of worsening of spinal canal compromise, especially if the posterior vertebral body wall is unstable.[12,13,17] This risk has made operators reluctant to perform vertebroplasty for patients with retropulsion. Although our study indicates that it is safe in patients with spinal canal narrowing, vertebroplasty should not be considered for the primary treatment for burst fractures.[10] It should only be used when conservative management has failed and the patient's medical condition justifies the risk.

The alternative procedure to vertebroplasty is kyphoplasty, in which cement is injected under low pressure into a preformed cavity.[15,18-21] The expansion of the vertebral body in kyphoplasty is accomplished by inflation of balloons before cement injection. In vertebroplasty, the cement is injected un-
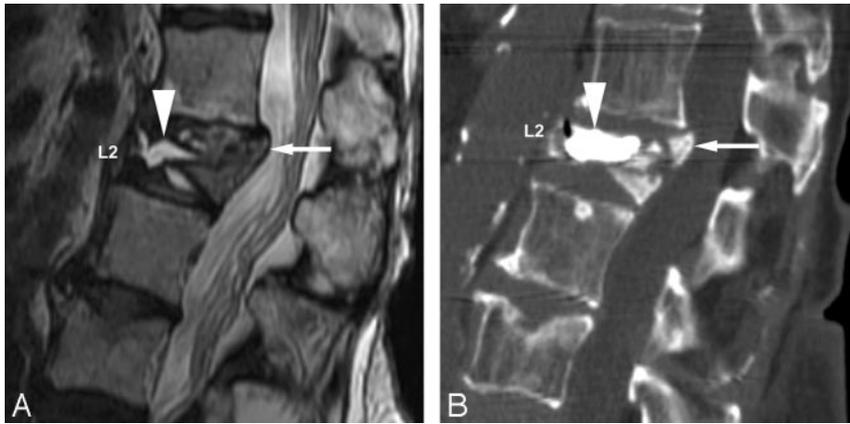
Fig 2. A 72-year-old woman with lower back pain without radiculopathy.

A, Sagittal T2-weighted image 6 days before vertebroplasty shows a severe compression fracture of the L2 vertebral body. Retropulsion of the bony fragment is noted, measuring approximately 5.4 mm (*arrow*). High signal intensity is seen in the anterior portion of the vertebral body (*arrowhead*).

B, Sagittal reformatted CT scan after vertebroplasty shows sufficient cement filling in L2 vertebral body (*arrowhead*). No prominent worsening of retropulsion is noted (*arrow*).

der higher pressure directly into the vertebral body. We do not know if there is any difference in the risk of aggravating the retropulsion between kyphoplasty and vertebroplasty. Further studies comparing the 2 techniques must be undertaken.

To better visualize possible posterior motion of the retropulsed fragment, we sometimes used intrathecal contrast (myelography) during the vertebroplasty.[14] This would not prevent posterior migration but would allow early visualization.

Vertebroplasty is primarily performed to eliminate or decrease pain that cannot be controlled with conservative treatment. As an extra benefit, vertebroplasty can also restore some of the lost vertebral body height and improve the wedge angle.[2-7] The results of this study confirm these earlier observations, with pain relief in 95% of the patients, a 1.6-mm increased vertebral body height, and a 5° decreased wedge angle after vertebroplasty. We believe that the high cement viscosity used in these cases helped in restoring vertebral body morphology compared with using a more liquid cement mixture.

Conclusion

Percutaneous vertebroplasty can be performed safely for painful vertebral body fractures with retropulsion and spinal canal compromise. This procedure decreases pain, increases vertebral height, and decreases wedge angle without aggravating retropulsion.

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