

## Back stab

### *Percutaneous vertebroplasty for severe back pain*

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#### ABSTRACT

**OBJECTIVE** To review the evidence supporting use of percutaneous vertebroplasty for relief of pain and mechanical stability in patients with vertebral compression fractures unrelieved by conventional measures.

**QUALITY OF EVIDENCE** Ovid MEDLINE was searched from January 1966 to December 2006 for all English-language papers on vertebroplasty. The quality of evidence in these papers was graded according to the 4-point classification system of evidence-based medicine. Level II evidence currently supports use of vertebroplasty.

**MAIN MESSAGE** Vertebroplasty alleviates pain from vertebral compression fractures that result from osteoporosis, hemangiomas, malignancies, and vertebral osteonecrosis. Vertebroplasty has provided substantial pain relief in 60% to 100% of patients; has decreased analgesic use in 34% to 91% of patients; and has improved physical mobility in 29% to 100% of patients. Contraindications to vertebroplasty include asymptomatic compression fractures of the vertebral body, vertebra plana, retropulsed bone fragments or tumours, active infection, uncorrectable coagulopathy, allergy to the bone cement or opacification agent, severe cardiopulmonary disease, pregnancy, and pre-existing radiculopathy. The short-term complication rate was found to be 0.5% to 54%. Rare but serious complications include compression of the spinal cord or nerve root, infection, cement embolization causing pulmonary infarct and clinical symptoms, paradoxical embolization of the cerebral artery, and severe hematomas.

**CONCLUSION** Vertebroplasty is a safe and effective treatment for vertebral fractures that cannot be treated using conservative measures.

#### RÉSUMÉ

**OBJECTIF** Faire le point sur les données qui supportent l'utilisation de la vertébroplastie percutanée pour soulager la douleur et assurer une stabilité mécanique dans les cas de tassements vertébraux rebelles au traitement conventionnel.

**QUALITÉ DES PREUVES** On a repéré dans Ovid MEDLINE entre janvier 1966 et décembre 2006 tous les articles de langue anglaise sur la vertébroplastie. La qualité des preuves contenues dans ces articles a été évaluée selon le système de classification en 4 points pour la médecine basée sur des données probantes. L'utilisation de la vertébroplastie est présentement supportée par des preuves de niveau II.

**PRINCIPAL MESSAGE** La vertébroplastie soulage la douleur des tassements vertébraux résultant d'ostéoporose, d'hémangiomes, de néoplasies et d'ostéonécrose vertébrale. Cette intervention a produit une importante réduction de la douleur chez 60 à 100% des patients; a entraîné une baisse de l'utilisation des analgésiques chez 34 à 91% des sujets; et a amélioré la mobilité des patients dans 29 à 100% des cas. Un taux de complications à court terme de 0,5 à 54% a été observé. Les complications graves sont rares; elles incluent: compression de la moelle épinière ou de racine nerveuse, infection, embolie de ciment avec infarctus pulmonaire cliniquement symptomatique, embolie paradoxale d'une artère cérébrale et hématome sévère.

**CONCLUSION** La vertébroplastie est une méthode sûre et efficace pour traiter les fractures vertébrales rebelles au traitement conventionnel.

This article has been peer reviewed.

Cet article a fait l'objet d'une révision par des pairs.

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**V**ertebroplasty is an image-guided procedure during which cement is injected into weak or collapsed vertebrae.<sup>1</sup> It is used to treat acute severe back pain that arises from osteoporotic or benign vertebral compression fractures, vertebral osteonecrosis, vertebral body hemangiomas, vertebral metastasis, and multiple myelomas when the pain does not resolve with conservative treatment (bed rest, analgesics, external back bracing, and physical therapy). Vertebroplasty is also used as an adjuvant therapy for preoperative, perioperative, or intraoperative percutaneous stabilization for spinal decompressive procedures.<sup>1-3</sup>

It is important to be aware of vertebroplasty, as fractures from osteoporosis are common and the clinical consequences are serious. Untreated vertebral fractures can cause pain, disability, and neurologic deficits. Multiple vertebral compression fractures can cause the spine to shorten or deform leading to postural instability and reduced ventilatory capacity.<sup>4</sup> Vertebroplasty should be considered for patients who fail to benefit from conservative management.

Kyphoplasty is a procedure that uses a balloon to restore the height of the vertebral body. To date, no scientific study has demonstrated a difference in efficacy between vertebroplasty and kyphoplasty.<sup>5</sup> As this is the case, this article will discuss vertebroplasty only.

Before vertebroplasty is performed, physicians should take a careful history, do a thorough physical examination, and obtain radiographs to correlate the area of pain with the level of the compression fracture. Focal neurologic deficits or myelopathy must also be excluded. Cross-sectional imaging, such as magnetic resonance imaging or computed tomography, should be done to exclude severe compromise of the spinal canal, to assess the integrity of the posterior vertebral elements, and to exclude other causes of back pain. Magnetic resonance imaging and nuclear medicine bone scans are valuable methods for estimating the severity of fractures.<sup>1</sup>

## Procedure

During the procedure, patients lie prone and are moderately sedated with medications, such as midazolam and fentanyl citrate. Strict adherence to sterile technique is essential to reduce the risk of infection in the injected cement. Local anesthetics are used to numb the skin, paraspinal muscles, and periosteum. High-quality fluoroscopic guidance is used so that a transpedicular or parapedicular approach can be used to insert an 11- to 13-gauge needle into the vertebral body. Bone cement (polymethylmethacrylate) in

liquid form is injected through the needle under real-time fluoroscopic control to ensure appropriate dispersal within the vertebral body. Patients then lie supine for 1 hour to allow the cement to solidify and are assessed for relief of back pain, neurologic deficits or new chest pain before same-day discharge. Pain relief is usually immediate but might take 72 hours.<sup>1</sup>

## Quality of evidence

Ovid MEDLINE was searched from January 1966 to August 2006 using the word *vertebroplasty* with the following MeSH search terms *therapy*, OR *treatment outcome*, OR *costs*, OR *benefits*, OR *side effects*, OR *cost-benefit*. Of 252 articles found, 205 remained after the search was limited to the English language. Most of the remaining articles were excluded on account of title, abstract, and key words if it was evident that they had fewer than 20 patients, did not use a clinical measure as outcome, concerned kyphoplasty, were review articles, or were duplicate studies. Nine articles remained and were analyzed. A similar secondary search was conducted using PubMed. Of the 574 English-language articles found with the term *vertebroplasty*, 4 were chosen and analyzed. References of all articles were scanned for other relevant papers. The data we present have come from large case studies and 1 nonrandomized controlled study that provided level II evidence dating back to the year 2000.

## Outcomes of vertebroplasty

Several large case studies have examined the outcomes of percutaneous vertebroplasty for compression fractures and tumours (**Table 1**). The research done by McGraw et al,<sup>6</sup> Diamond et al,<sup>7</sup> Anselmetti et al,<sup>8</sup> Winking et al,<sup>9</sup> Zoarski et al,<sup>10</sup> and Kobayashi et al<sup>11</sup> has shown that, after vertebroplasty, 60% to 100% of patients had substantial pain relief, 34% to 91% of patients used fewer analgesics, and 29% to 100% of patients had improved mobility. The studies done by Do et al,<sup>12</sup> Vogl et al,<sup>3</sup> Prather et al,<sup>13</sup> Purkayastha et al,<sup>2</sup> Winking et al,<sup>9</sup> Evans et al,<sup>14</sup> McKiernan et al,<sup>15</sup> and Grados et al<sup>16</sup> showed that, after vertebroplasty, pain scores on a 10-point visual analogue scale decreased from 8.9 to 0.05, analgesic use scores decreased from 2.93 to 0, and ambulation impairment scores decreased from 7.2 to 0.11. Diamond et al<sup>7</sup> found that 29 patients who underwent percutaneous vertebroplasty had 43% fewer days of hospitalization than inpatients treated with conservative methods.

## Benefits

The primary benefits of vertebroplasty are less pain, less analgesic use, better mobility, and shorter recovery times, which mean less need for nursing and rehabilitation care. With vertebroplasty, there is less chance of complications arising from vertebral compression fractures, such as deep venous thrombosis, osteoporosis

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**Table 1. Results of studies on vertebroplasty procedures**

AUTHOR, YEAR	NO. OF PATIENTS	FOLLOW-UP TIME	SYMPTOM RELIEF	COMPLICATIONS
McGraw et al, <sup>6</sup> 2002	100 with compression fractures of the vertebral body	Mean 21.5 mo (range 6-44 mo)	97 patients (97%) reported substantial pain relief 24 hours after treatment, and 3 (3%) reported no change; 91 patients (91%) reduced their daily intake of oral analgesics; 93 patients (93%) reported great improvement in back pain and better ambulation, and 7 (7%) reported no change	1 patient (1%) had transient radiculopathy lasting 12 hours; 1 patient (1%) suffered a sternal fracture while transferring from stretcher to procedure table
Diamond et al, <sup>7</sup> 2006*	126 with acute osteoporotic vertebral fractures: 88 (70%) were treated with percutaneous vertebroplasty, and 38 (30%) were treated with conservative therapy; 72 outpatients, 54 inpatients	2 y	With vertebroplasty, there was a 60% reduction in pain scores from 20 to 8 ( $P < .001$ ), a 29% improvement in physical function scores from 14 to 18 ( $P < .001$ ), and a 43% reduction in total number of hospital-bed days. Both groups had similar pain scores at 12 and 24 mo	1 patient (1%) whose heparin had been inadvertently continued hemorrhaged into the psoas muscle, and 2 (2%) had fractured transverse processes at least 2 vertebrae away. There was no major difference in rates of new vertebral fractures or death between groups
Anselmetti et al, <sup>8</sup> 2005	49 patients with 108 vertebrae treated: 28 had osteoporotic compression fractures; 21 had benign or malignant infiltrative processes	6 mo (mean 3.8 mo)	After 1 day, 41 patients (83.7%) reported reduced pain or no pain that lasted the entire follow-up period; use of analgesics was reduced from 100% to 6.1%; there was 100% improvement in mobility	8 patients (16.3%) had transient pain at the puncture site or radiculopathy that lasted a maximum of 1 mo; of 8 patients (16.3%) who had recurrent pain, 7 were relieved with vertebroplasty at another level, and 1 refused further investigations; 63 of the 108 vertebrae treated (58.3%) had small asymptomatic cement leaks; 1 patient (2%) had a subcutaneous paravertebral hematoma that needed hospitalization and blood derivative transfusion but resolved in a week; 2 patients (4%) had asymptomatic small pulmonary embolisms of cement
Winking et al, <sup>9</sup> 2004	38 with osteoporotic vertebral compression fractures	1 y	35 patients (92%) reported substantial reduction in pain right after treatment and for a year after that; pain scores decreased from 7 (range 3.9 to 8.7) to 1.8 (range 0.8 to 3.9) 2 days after treatment ( $P < .01$ ); and to 2.6 (range 0.8 to 4.6) by 6 mo later ( $P < .01$ ); 13 patients (34%) stopped using analgesics 6 weeks after treatment, and 2 (5%) continued to use the same dosage of analgesics; 21 patients' (55%) mobility improved; mobility problem scores decreased from $3.7 \pm 0.2$ to $1.7 \pm 0.1$ within 2 days after vertebroplasty	10 patients (26%) had minor cement leakage

Table continued...

AUTHOR, YEAR	NO. OF PATIENTS	FOLLOW-UP TIME	SYMPTOM RELIEF	COMPLICATIONS
Zoarski et al, <sup>10</sup> 2002	30 with osteoporotic vertebral compression fractures; 54 vertebrae	15–18 mo	29 patients (97%) reported pain relief right after the procedure; 2 weeks after the procedure, 24 patients (80%) reported better physical function ( $P = .004$ ), less pain and disability ( $P < .0001$ ), and better mental function ( $P = .0009$ )	1 patient (3%) had asymptomatic cement leakage
Kobayashi et al, <sup>11</sup> 2005	205 with osteoporotic vertebral fractures; 250 injections; only 196 understood pain assessment scale	34 mo	Pain improved in 189 of 196 cases (96.4%), disappeared in 44 cases (23.3%), and did not change in 6 cases (3.1%); in 196 cases, pain scores decreased from $7.22 \pm 1.89$ (range 3–10) to $2.07 \pm 1.19$ (range 0–10); of 115 immobilized patients, 94 (81.7%) were mobile by 24 h (mean $1.9 \pm 2.8$ days)	Pain increased in 1 case (0.5%) due to degenerative spinal stenosis; asymptomatic leakage of bone cement was seen in 189 injections (75.6%); 1 case (0.5%) had a hematoma; 2 cases (1%) had transient nausea right after the cement injection; in the 205 injections, 32 (15.6%) had recurrent and new fractures within 4–25 mo (mean 15.3 mo)
Evans et al, <sup>14</sup> 2003	245 patients with osteoporotic compression fractures	Median of 7.2 mo	Decrease in pain from $8.9 (\pm 7)$ to $3.4 (P < .001)$ ; decrease in impaired ambulation from 72% to 28% ( $P < .001$ ); significant improvement in ability to perform activities of daily living from 0 to 63% ( $P < .001$ )	12 patients (4.9%) had symptomatic complications; 3 (1.2%) reported worsening pain; 2 (0.8%) had temporary radicular pain relieved by nerve-root injection in 1 and partially relieved in the other; 7 (2.9%) had a rib fracture within 24 h
Do et al, <sup>12</sup> 2005	167 with osteoporotic vertebral compression fractures unresponsive to medical therapy	1 mo, 6 mo, and 3 y for quality of life	Pain scores decreased from 8.71 (SE 0.1) to 2.77 (SE 0.18, $P < .00001$ ); use of analgesic scores decreased from 2.93 (SE 0.9) to 1.64 (SE 0.09, $P < .00001$ ); health scale scores improved significantly after long-term follow-up ( $P < .02$ )	
Vogl et al, <sup>3</sup> 2005	61 with osteoporotic vertebral compression fractures	Mean 19.8 mo (range 3–52 mo)	Significant reduction in pain scores from 8.8 (range 6.5–9.8) to 2.6 (range 1.5–4.1, $P < .01$ ) in all patients	Minor asymptomatic bone cement leakage in 54%
Prather et al, <sup>13</sup> 2006	50 with intractable pain from osteoporotic compression fractures for at least 4 wk	1 y	Significant improvement in functional pain scores from a mean of 7.76 at baseline to a mean of 2.9 ( $P < .0001$ ) 1 month after vertebroplasty and maintained for 1 year (mean 2.9)	No adverse reactions
Purkayastha et al, <sup>2</sup> 2005	46: 24 with osteoporotic compression collapse, 26 with hemangiomas, 15 with various vertebral body tumours and metastases; 65 vertebroplasties	3–48 mo	1 mo after vertebroplasty, significant reduction in pain scores from 6.7 (SE 1.427) to 0.05 (SE 0.226, $P < .001$ ), decrease in analgesic use from 1 (SE 0.465) to 0 ( $P < .001$ ), decrease in impaired activity scores from 0.84 (SE 1.053) to 0.11 (SE 0.388, $P < .001$ )	Prevertebral or paravertebral venous filling and disc space filling in 3 procedures (4.61%); mild epidural leaks in 2 procedures (3.07%); paravertebral soft tissue extravasations in 4 procedures (6.15%)
McKiernan et al, <sup>15</sup> 2004	46 with osteoporotic vertebral fractures; 66 vertebrae treated	6 mo	Decrease in mean pain scores from $7.7 \pm 1.8$ to $2.8 \pm 1.8$ ( $P < .001$ ) 1 day after vertebroplasty that continued after 2 wk, 2 mo, and 6 mo ( $P < .001$ ); improvement in quality of life 2 wk after procedure that remained after 6 mo ( $P \leq .007$ )	10 cement leaks from 66 vertebrae (15%); 3 patients (6.5%) had incidental vertebral compression fractures

Table continued...

AUTHOR, YEAR	NO. OF PATIENTS	FOLLOW-UP TIME	SYMPTOM RELIEF	COMPLICATIONS
Grados et al, <sup>16</sup> 2000	25 with symptomatic osteoporotic vertebral fractures unresponsive to maximum medical therapy	Mean 48 mo (range 12–84 mo)	Significant reduction in pain scores from a mean of 80 (SE 16) to 37 (SE 24) after 1 mo ( $P < .05$ ) and 34 (SE 28) at the last follow-up visit	No severe complications: 2 patients (8%) had transitory nerve root pain resolved with analgesics in 2 days; 1 patient (4%) had transitory exacerbated pain that lasted <2 days; 7 patients (28%) had leakage of material into the disk space with no clinical effect; 1 patient (4%) had cement embolism to the lungs with no respiratory changes; 2 patients (8%) had transitory fever that resolved spontaneously in 2 days; there was a slightly increased risk of vertebral fractures in the area of cemented vertebrae (odds ratio 2.27, 95% confidence interval 1.11–4.56)

SE—standard error  
 \*The only nonrandomized trial.

acceleration, height loss, respiratory problems, gastrointestinal troubles, and emotional and social issues arising from severe pain.<sup>1</sup>

### Contraindications

Contraindications to vertebroplasty include asymptomatic compression fractures of the vertebral body, vertebra plana, retropulsed bone fragments or tumours, active infection, uncorrectable coagulopathy, allergy to the bone cement or opacification agent, severe cardiopulmonary disease, pregnancy, or pre-existing radiculopathy.<sup>2–4,7,17</sup>

### Cautions

Before the procedure, imaging is important. Recent spine radiographs, computed tomography scans, magnetic resonance imaging scans, and nuclear medicine bone scans are recommended to ensure an accurate understanding of the anatomy and to assess the age of fracture sites. For patients with acute fractures, it is best to defer the procedure for at least 4 weeks to allow for spontaneous healing and resolution of pain. Direct physical examination under fluoroscopy is also essential to confirm that the site of pain corresponds with the location of the fracture. Usually, single-session treatment is limited to 3 or fewer vertebral levels. Some researchers have suggested that patients younger than 65 should avoid vertebroplasty because their bones might heal spontaneously, and the long-term effects of vertebroplasty are unknown.<sup>1,3,17</sup>

### Complications

Minor complications due to vertebroplasty have been reported. Recent studies have shown that short-term complications occurred in 0.5% to 76% of procedures (Table 1). Transient pain was noted in 0.5% to 16.3% of patients.<sup>6,8,11,14,16</sup> Asymptomatic cement leakage was noted in 1% to 54% of patients<sup>3,9,10</sup> and in 3% to 76% of injections.<sup>2,8,11,15,16</sup> Hematoma occurred in 0.6% to 1%

of patients,<sup>7,11</sup> asymptomatic pulmonary embolism was seen in 3.5% to 5% of patients,<sup>8,16</sup> transient nausea was noted in 1% of patients,<sup>11</sup> and transient fever was noted in 8% of patients.<sup>16</sup> Fractures were seen in 2% to 7% of patients<sup>7,14,15</sup> and in 16% of injections.<sup>10,11</sup> Grados et al<sup>16</sup> reported that there was a slightly increased risk of vertebral fractures in the area of a cemented vertebra (odds ratio 2.27, 95% confidence interval 1.11 to 4.56). Other transient minor complications included allergic contact dermatitis from the cement and pneumothorax in patients with thoracic lesions.<sup>1,4</sup>

Rare but serious complications of vertebroplasty have been reported. Anselmetti et al<sup>8</sup> described 1 patient (1.7% of patients studied) who experienced a subcutaneous paravertebral hematoma that required hospitalization and blood derivative transfusion and took 1 week to resolve. Other serious complications include spinal cord compression, neurologic complications (such as optic neuritis), paradoxical embolization of the cerebral artery from cement leaking into epidural veins, or cement embolization via the paravertebral venous plexus to the lungs causing pulmonary infarction and clinical symptoms.<sup>1,12,13,17,18</sup> In rare cases, extruded cement requires decompressive surgery.<sup>1</sup> In most cases where neurologic symptoms occurred after cement extravasation, the procedures were not performed using high-quality real-time fluoroscopic imaging. Finally, the polymethylmethacrylate cement releases heat during polymerization that can damage osteocytes. These osteocytes are not resorbed, which can lead to bone degeneration later in life.<sup>4</sup>

### Other treatments

Conservative measures should be attempted before treating with vertebroplasty. Conservative treatments include bed rest, analgesics, external back bracing, and physical therapy. If conservative treatments fail, some evidence indicates that nerve-root injection should be



considered for patients with radicular pain. Kim et al<sup>19</sup> treated 58 patients with painful osteoporotic vertebral fractures by injecting their nerve roots with lidocaine, bupivacaine, and methylprednisolone. The injections were repeated at 2-week intervals to a maximum of 3 injections or until symptoms improved. Mean pain scores decreased from 85.0 before treatment to 24.9 at 1 month and to 14.1 at 6 months after treatment. The authors suggested that nerve-root injections should be considered before percutaneous vertebroplasty or operative intervention for patients with vertebral fractures and radicular pain.<sup>19</sup>

## Future of vertebroplasty

Several advances can improve the vertebroplasty technique. First, biodegradable or bioactive materials that augment bone are being researched, as they can help induce new bone growth.<sup>1</sup> Combining vertebroplasty with kyphoplasty, where the inflation of a high-pressure balloon is used to restore the height and shape of the vertebral body and then the cavity is filled with cement, could be helpful.<sup>1</sup> The long-term effects of bone cement need to be studied; for example, the potential risk of new fractures in adjacent vertebrae must be further investigated. Finally, randomized controlled trials are needed to compare vertebroplasty with conservative treatment.

## Availability in Canada

A substantial number of radiologists (interventional radiologists, neuroradiologists, and musculoskeletal radiologists) do percutaneous vertebroplasty in Canada. An unpublished survey of the Canadian Interventional Radiology Association showed that, in 2005, of a total of 75 responding interventional radiologists, 59% were at centres that performed vertebroplasty with a 2- to 8-week wait time from time of referral to time of procedure. Of the respondents not performing vertebroplasty, 28% anticipated beginning to perform the procedure 1 year after the time of the survey. A partial list of radiologists across Canada who perform vertebroplasty and their contact information is available from [www.cfpc.ca/cfp/2007/Jul/\\_images/vol53-jul-clinicalreview-banerjee-list.png](http://www.cfpc.ca/cfp/2007/Jul/_images/vol53-jul-clinicalreview-banerjee-list.png). Any radiology department can be contacted to find out whether someone there performs vertebroplasty.

## Conclusion


Vertebroplasty is an effective treatment for symptomatic vertebral compression fractures arising from osteoporosis, hemangiomas, malignancies, and vertebral osteonecrosis that have not been cured by conservative treatment. Patients have reported less pain, less use of analgesics, improved mobility, and better quality of life after vertebroplasty. Vertebroplasty should not be used for patients with asymptomatic compression

## EDITOR'S KEY POINTS

- Percutaneous vertebroplasty as a treatment for vertebral compression fractures is increasingly available in Canada. Studies have shown considerable benefit in pain relief and shorter recovery times, and complications tend to be minor and transient. Serious complications have generally occurred when procedures were not performed under high-quality, real-time fluoroscopic imaging.
- There are still some unanswered questions. Should patients younger than 65 have this procedure? What is the risk of new fractures adjacent to the treatment site? What are the long-term effects of percutaneous vertebroplasty? More randomized controlled trials are needed.

## POINTS DE REPÈRE DU RÉDACTEUR

- La vertébroplastie percutanée est de plus en plus disponible au Canada pour traiter les tassements vertébraux. Les études ont montré que cette intervention procure un soulagement considérable et une récupération plus rapide, la plupart des complications étant relativement mineures et transitoires. Les complications plus graves surviennent généralement lorsque les interventions ne sont pas effectuées avec une imagerie fluoroscopique de grande qualité.
- Certaines questions demeurent. Les patients de moins de 65 ans devraient-ils subir cette intervention? Quel est le risque de nouvelle fracture au voisinage du site traité? Quels sont les effets à long terme de la vertébroplastie percutanée? D'autres essais randomisés seront nécessaires pour clarifier ces points.

fractures of the vertebral body, vertebra plana, retropulsed bone fragments or tumour, active infection, pre-existing radiculopathy, uncorrectable coagulopathy, allergy to cement or the opacification agent, severe cardiopulmonary disease, pregnancy, or pre-existing radiculopathy. Complications include pain, asymptomatic bone cement leakage, hemorrhage, nausea, fever, nerve-root irritation, rib or vertebral posterior element fractures, contact dermatitis, osteocyte degeneration, and pneumothorax. Rare but possible serious complications include severe hematomas, neurologic complications, paradoxical cerebral arterial embolization, and cement embolization causing pulmonary infarct and clinical symptoms. 

## Competing interests

*None declared*

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**Canadian Interventional Radiologists who currently perform percutaneous vertebroplasty and can be contacted for referrals: *Contact information given is how physicians prefer to be reached***

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Alberta	Calgary	Dr Bevan Frizzell Dr Will Morrish Dr Roy Park	Foothills Medical Centre Department of Diagnostic Imaging 1403–29 St NW Calgary, AB T2N 2T9	Telephone 403 944-1969 Fax 403 944-4011
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