MEDWELL PUBLISHING
Research Journal of Biological Sciences 4 (1): 1-6, 2009
ISSN: 1815-8846

CT Fluoroscopy Guided Vertebroplasty for Treatment of Painful Vertebral Compression Fractures

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Abstract: Our purpose in this study was to determine the results of CT fluoroscopy guided Percutaneous Vertebroplasty (PVP) in pain reduction from vertebral compression fractures and its complications. During a 3 year period, 59 patients (39 female, 20 male) with persistent low back pain and back pain underwent percutaneous injection of cement into the vertebrae under fluoroscopic guidance. Among our patients, 30 cases (50.8%) had thoracic pathology, 26 (44.1%) lumbar pathology and 3 (5.1%) both thoracic and lumbar involvement. Severity of low back pain and back pain was assessed by using visual analog scale (VAS) before and after one and 6 months intervals thereafter. The mean age of our cases was 63.5±11.3 years (range: 25-97). Thirty two procedures (54.3%) were performed for osteoporotic compression fracture, 13 (22%) for hemangioma, 9 (15.3%) for traumatic fracture and 5 (8.5%) for metastasis. Mean volume of cement injected was 5.3±1.6 mL (3-10 mL) in osteoporotic vertebrae, 4.7±1.4 mL (2-7 mL) in hemangiomas, 6.2±2.4 mL (3-10 mL) in traumatic fractures and 4.4±0.9 mL (4-6 mL) in vertebrae affected by metastasis ($p = 0.17$). Reduction in pain immediately after the procedure was seen in 71.9% (23 from 32 cases) for osteoporosis 77.8% (14 from 18 cases) for tumoral lesions and 55.6% (5 from 9 cases) for traumatic fractures ($p = 0.48$). Mean pain reduction after 6 months was significantly higher than mean reduction after one month (55.9±24.9% versus 45.7±24.8%; $p<0.0001$). CT fluoroscopy guided PVP is a safe and efficacious procedure resulting in pain reduction among patients with vertebral compression fractures.

Key words: CT fluoroscopy, vertebroplasty, bone cement, compression fracture

INTRODUCTION

Vertebral compression fractures are an important healthcare problem in the world, due to the high incidence, its effects on health-related quality of life and also the costs to the healthcare system (Boswell *et al*., 2007; Hulme *et al*., 2006; Taylor *et al*., 2006).

Vertebral fractures may cause discomfort and pain. Pain reduction and stabilization is very important in the management of osteoporotic vertebral compression fractures as well as fractures due to trauma, tumors and hemangiomas (Gill *et al*., 2007).

For patients who have severe persistent pain, vertebroplasty is an alternative treatment option for the management of intractable pain.

Percutaneous Vertebroplasty (PV) is a minimally invasive technique that was developed in 1984 for the treatment of painful aggressive vertebral hemangioma (Galibert *et al*., 1987).

It was later performed for vertebral compression fractures caused by osteoporosis, trauma, malignant or benign vertebral tumors and vertebral osteonecrosis (Barr *et al*., 2000; Cortet *et al*., 1999; Mathis *et al*., 2001).

Nowadays, PV is considered as a useful therapy in many centers for pain relief and strengthens the vertebrae by percutaneous injection of cement into the vertebral body (Klazen *et al*., 2007; Purkayastha *et al*., 2005).

Early pain relief after this procedure was reported in >80% of the patients (Alvarez *et al*., 2005; Levine *et al*., 2000).

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Since, the first PV procedure, fluoroscopy has been the preferred modality of image guidance for performing PV (Mathis *et al*., 2001). Even though Computed Tomography (CT) has rarely been used as a primary or adjunctive tool (Barr *et al*., 2000; Gangi *et al*., 1994) there are few centers that perform CT fluoroscopy guided PVP (Kim *et al*., 2005).

The aim of this study, was to evaluate and report the therapeutic effects of CT fluoroscopy guided PVP in pain reduction from vertebral compression fractures and its complications in our university affiliated hospital.

MATERIALS AND METHODS

We performed CT fluoroscopy guided percutaneous vertebroplasty in 59 consecutive patients between 2004 and 2007 in our institution. Informed consent was obtained for all patients. We included patients, who had localized pain, pain refractory to medical management, or a fracture less than 12 months old. We excluded patients with severe cardio-pulmonary conditions, coagulopathies, osteomyelitis, spondylodiscitis, fracture extending to posterior vertebral cortex, thecal sac and cord compression, fever and/or sepsis, or coagulopathies.

All patients underwent plain x-ray for diagnosis of vertebral compression fractures and also MRI to determine if there was significant spinal canal compromise, to evaluate the integrity of the posterior vertebral body wall and to exclude other causes of back pain.

About 30 min prior to the procedure, we prescribed prophylactic antibiotic (keflin 2 g intravenously) and 200 mg hydrocortisone for all patients.

All vertebroplasties were done under CT fluoroscopic (Sensation 4, Siemens Medical Solutions, Germany) guidance, under sterile conditions.

First of all we placed the patients in prone position. Then, we obtained the scout view for selection of proper needle insertion. According to imaging guidance we understood that we could tilt the needle, 10-15°. Local anesthesia was performed using 5cc of lidocaine 5% from skin to the periosteum of the pedicle. We inserted 22 Gauge bone biopsy needle (Optimeter) adjacent to the pedicle and infiltrated 5cc of lidocaine 5%. Then we injected cement (calcibone S-Merck, Kyphx-Kyphon) under CT-fluoroscopy guidance in a way whereby we could excellently control the pattern of cement distribution in the vertebrae. We continued injection of cement till we saw the possibility of venous reflux to the thecal sac. We did not perform venography in our patients and when unilateral needle insertion was not enough for cement distribution, we inserted bilateral needles. In one patient who had hemangioma and had undergone previous laminectomy, we embolized T8 intercostal artery to avoid cord compression after vertebral fracture and epidural hematoma. After adequate vertebral filling, the needle was removed. In some cases, venous bleeding was experienced at the needle insertion site and hemostasis achieved with local pressure for 5 min. After the procedure, all patients were kept in a recumbent position for 2 h and monitored for changes in neurologic function and adverse effects. All patients with uneventful recovery were discharged after 3-4 h.

Severity of back pain was assessed by using visual analog scale (VAS) (0 = no pain; 10 = most severe pain) before and after 1 month and at 6 months intervals thereafter.

Post procedure evaluation of complications was evaluated in post procedure imaging and clinical examinations.

Statistical analysis was performed by using SPSS ver 11.5. A probability value of less than 5% ($p<0.05$) was considered significant.

RESULTS

Among 59 patients that underwent PV, 39 patients (66.1%) were female and 20 (33.9%) were male. The mean (SD) age of our patients was 63.5±11.3 (range: 25-97). Among our patients, 30 cases (50.8%) had thoracic pathology, 26 (44.1%) lumbar pathology and 3 (5.1%) both thoracic and lumbar involvement.

There was no difference between age of our patients according to thoracic, lumbar or both thoracic and lumbar ($p = 0.5$). Thirty two procedures (54.3%) were performed for osteoporotic compression fracture, 13 (22%) for hemangioma, 9 (15.3%) for traumatic fracture and 5 (8.5%) for metastasis. Mean age of patients in metastasis, osteoporosis, hemangioma and traumatic fractures was 57±4.5, 66.5±9.7, 56.2±12.4 and 67.3±12.6, respectively ($p = 0.018$). Totally, 64 vertebrae in 75 session were treated by cement injection. Mean cement volume was 5.2±1.7cc (2-10cc). Mean cement injected was 5.3±1.6 mL (3-10 mL) in osteoporotic vertebrae, 4.7±1.4 mL (2-7 mL) in hemangiomas, 6.2±2.4 mL (3-10 mL) in traumatic fractures and 4.4±0.9 mL (4-6 mL) in vertebrae affected by metastasis ($p = 0.17$). Mean cement volume in thoracic and lumbar vertebrae was 5.3±1.6cc and 5.1±1.8cc, respectively ($p = 0.6$). No major complications occurred during the procedures and we had no patients with pulmonary embolisation.

Mild peritechal leak was seen in one procedure. Reduction in pain immediately after the procedure was

Table 1: Mean pain reduction according to pathology and involved vertebrae

	Pain reduction after one month (%)	p-value	Pain reduction after 6 months (%)	p-value
Pathology				
Tumoral	41.7±25.9	0.75	50.5±29.8	0.84
Osteoporosis	47.6±24.2		59.4±22.6	
Trauma	00.45±27.8		56.2±23.7	
Involved vertebrae				
Thoracic	45.6±22.2	0.55	54.6±26.2	0.81
Lumbar	49.1±25.4		56.9±24.5	

seen in 71.9% (23 from 32 cases) for osteoporosis 77.8% (14 from 18 cases) for tumoral lesions and 55.6% (5 from 9 cases) for traumatic fractures ($p = 0.48$).

There were no differences in pain relief immediately after the procedure according to affected vertebra (73.1% in lumbar versus 73.3 in thoracic; $p = 0.92$). Mean pain reduction according to VAS after one month in females was 42±23.9% and in males was 52.9±25.7% ($p = 0.15$). Mean pain reduction according to VAS after 6 months in males and females was 51.2±22.2% and 64.6±28.1%, respectively ($p = 0.14$). Mean pain reduction after 6 months was significantly higher than mean reduction after one month (55.9±24.9% versus 45.7±4.8%; $p<0.0001$).

Mean pain reduction according to pathology and involved vertebrae are summarized (Table 1).

DISCUSSION

The potential problems of vertebral compression fractures if untreated are pain, reduced mobility, urinary retention, ileus, or spinal cord compression. Kyphosis, insomnia, depression, loss of employment and narcotic addiction are other adverse outcomes of this condition (Afzal *et al*., 2007; Bostrom and Lane, 1997). Conservative therapy, analgesic medication and bracing, were widely used for the treatment of symptomatic compression fractures. Percutaneous vertebroplasty has been used for the treatment of painful vertebral lesions as an effective and minimally invasive procedure (Cortet *et al*., 1999; Cotton *et al*., 1998; Cyteval *et al*., 1999). This procedure was first used in the treatment of vertebral hemangioma (Galibert *et al*., 1987; Laredo *et al*., 1986) and also has been shown to be very effective for relieving the pain caused by compression fractures in osteoporotic patients (Mathis and Wong, 2003). It also, has benefit in pain reduction for compression fractures associated with tumors and metastases (Mathis and Wong, 2003).

The goal of percutaneous vertebroplasty is reduction of pain due to compression fractures in vertebrae. The main mechanism of this procedure for symptom reduction is not known to date, but it may be due to that cement restores the biomechanical integrity of the fractured vertebrae thereby leading to return of its rigidity (Belkoff *et al*., 2001). As effect of the cement consolidation, stabilization of the vertebral body takes place during several minutes and subsequently may cause immediate reduction of focal pain at the treated point (Siddall and Cousins, 1997). CT has been used in some interventions of the spine, such as periradicular steroid injection, percutaneous laser disc decompression and facet joint block (Gangi *et al*., 1998).

Real-time monitoring and full profile imaging of the target area are very important in PVP.

Combination of CT and fluoroscopic guidance allows more accurate and safe needle navigation in PVP especially for the cervical and upper thoracic spine (Gangi *et al*., 2003, 1994) although, its high cost is one limitation of this combination (Mathis *et al*., 2001). CT fluoroscopy (CTF) is one imaging modality that permits real-time monitoring of CT images at a rate of 6-8 frames per second. CTF is also very useful in interventional procedures (Meyer *et al*., 1998; Silverman *et al*., 1999) especially, in drainage procedures and in biopsy of the thorax and abdomen. With CTF we are able to monitor the full passage of needle advance to the vertebral body, ensuring the procedure to be very safe (Kim *et al*., 2005). Martin *et al*. (1999) in their study conducted on 40 patients reported a success rate of 80% and very low complications. The reported pain relief in tumors after PV is between 65 and 80% (Cortet *et al*., 1997; Weill *et al*., 1996).

In one study that was conducted by Gangi *et al*. (1999) in patients who underwent PV; the authors reported pain relief in 78% of cases with osteoporosis. Pain relief in patients with malignant lesions and hemangiomas was 83 and 73%, respectively.

Although, we performed CTF guided vertebroplasty, our results for pain relief in osteoporosis and tumoral compression fractures (Gangi *et al*., 1999).

In our study, we performed vertebroplasty in all patients under CT fluoroscopic guidance because of real time visualization. We did not perform venography in our patients due to that previous studies showed no disadvantages and safety benefit for its use (Gaughen *et al*., 2002; Wong and Mathis, 2002).

In one study, that was conducted by Kim *et al*. (2005) PVP was performed under the CTF guidance on 29 vertebral bodies in 21 patients with compression fractures. They detected early cement leakage in 5 patients and pain was significantly decreased after the procedure and they found no obvious complications after PVP.

Pain relief after vertebroplasty in our patients was 73.1% in lumbar versus 73.3 in thoracic vertebrae that is

similar to many other PVP that performed under fluoroscopy guidance. The reported complications after vertebroplasty for osteoporotic vertebral compression fractures are about 1% (Cyteval *et al.* 1999).

The majority of complications are minor and transient. Complications are higher with inexperienced physicians or those, who perform the vertebroplasty without suitable image guidance.

One complication is the cement leakage from the vertebra adjacent to nerve root that may cause radicular pain, or rarely pulmonary embolus (Mathis and Wong, 2003). The leakage of cement has been reported in the literature and we had one case with peritechal leakage which was lower than some other studies. One possible cause of this maybe due to that we use CT fluoroscopy and monitored the injection of cement and stopped the injection (at least temporarily) when a leakage was observed. Other potential complications of this procedure include fractures of posterior elements of pedicles, infection and hemorrhage (Afzal *et al*., 2007). The complications of this procedure for malignant tumors or metastases are considerably higher (Mathis and Wong, 2003; Weill *et al*., 1996). One cause of this higher rate is due to that frequently lytic sites in the vertebral cortex of these patients exists that providing higher cement leakage into the adjacent tissue or vessel (Mathis and Wong, 2003). We found that the mean pain reduction in our patients after 6 months was significantly higher than one month after the procedure. This shows that in patients who have some pain following one month after the procedure a possibility exist that their pain might reduce later. One limitation of this study was that we did not evaluate the quality of life in our patients and outcomes were only according to pain scale, patient satisfaction and complications. Another limitation was that we had not control group for comparison.

CONCLUSION

In conclusion, by using suitable guidance modality, the number of complications may reduce. CT fluoroscopic guided vertebroplasty is a safe and efficacious procedure resulting in pain reduction among patients with vertebral compression fractures.

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