Formosan Journal of Musculoskeletal Disorders 4 (2013) 33–37

Contents lists available at SciVerse ScienceDirect

Formosan Journal of Musculoskeletal Disorders

journal homepage: www.e-fjmd.com

Original Article

Clinical and radiographic outcome of pillow reduction prior to vertebroplasty on patients with vertebral compression fracture

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ARTICLE INFO

Article history:
Received 8 October 2012
Received in revised form
25 January 2013
Accepted 1 February 2013
Available online 10 May 2013

Keywords:
vertebral compression fracture
vertebroplasty
postural reduction

ABSTRACT

Background/Introduction: Vertebroplasty has been proved to be effective in relieving the pain caused by osteoporotic vertebral fracture. However, there have been some limitations in restoring the vertebral body height and regaining lumbar lordosis. For this reason, postural reduction combined with subsequent vertebroplasty was reported to have a significant effect on height restoration.
Purpose: To compare vertebroplasty combined with postural reduction to ordinary vertebroplasty with respect to effective restoration of vertebrae height and lumbar lordosis.
Materials and methods: We reviewed patients with a single-level thoracolumbar vertebrae compression fracture who received vertebroplasty between November 2009 and December 2010. All patients had received routine radiographic examination and results of their magnetic resonance imaging scan were studied. Patients who underwent postural reduction with a soft pillow were assigned to Group A; all others were assigned to Group B. After the surgery, the radiographic outcome was recorded with follow-up for 1 year. The compression ratio (anterior height/posterior height) and Cobb angle were measured to analyze the degree of re-expansion. In addition, clinical outcome was also assessed using a visual analog scale (VAS).
Results: There were 13 males and 33 females, and their mean age was 77.4 years. The average preoperative compression ratio was 0.48 ± 0.18 and 0.51 ± 0.18, and Cobb angle was 20.2° ± 6.8° and 19.1° ± 7.7° among patients in Group A and Group B, respectively. Patients in each group were divided into either Group 1 (preoperative compression ratio < 0.40) or Group 2 (preoperative compression ratio > 0.40). The difference between the compression ratio prior to and after vertebroplasty was 0.36 ± 0.06 and 0.17 ± 0.48 in Group A-1 and Group B-1, respectively ($p < 0.01$) and 0.3 ± 0.13 and 0.26 ± 0.11 in Group A-2 and Group B-2, respectively ($p > 0.05$). Their average VAS after the vertebroplasty was 1.9 ± 0.8 and 1.7 ± 0.65 in Group A and Group B, respectively ($p > 0.1$).
Conclusion: Pillow reduction prior to vertebroplasty provided good efficacy to restore anterior height, especially in patients with greater anterior height loss.

1. Introduction

The incidence of osteoporosis is likely to increase fourfold during the next 50 years.[1] It has been defined as a generalized decrease of bone mass and deterioration in bone microarchitecture causing susceptibility to fracture. Osteoporotic vertebral compression fractures are common among osteoporotic patients and cause many complications, the effects of which are debilitating, long lasting, and expensive. Approximately two-thirds of patients with osteoporotic vertebral compression fractures are asymptomatic and receive no clinical attention.[2] The other one-third, however, experience problems and may develop chronic pain and complications such as chronic back pain, reduced physical and social function, kyphotic deformity,[3] and eventually a worsening of quality of life.[4]

In patients with symptomatic vertebral compression fracture, pain relief could be achieved with conservative treatment, including bed rest, analgesics, and external bracing.[5] However, nonunion of a vertebral compression fracture could be refractory to conservative treatment and can lead to persistent back pain and progressive kyphosis.[6,7] Even with appropriate therapy and treatment, these patients could develop chronic pain.

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2210-7940/$ – see front matter
http://dx.doi.org/10.1016/j.fjmd.2013.04.001

Vertebroplasty has been performed in the United States since 1993 and has been shown to achieve statistically significant pain relief.[8,9] It has been reported to reduce pain within 72 hours of injection[10] and to sustain this pain reduction during mid-term[11] and long-term[12] follow-up. However, vertebroplasty does not expand the collapsed body and has limitations in the restoration of vertebral body height. The subsequent kyphotic deformity could result in the alteration of the spine's biomechanical environment and may favor additional fractures.[13] Thus, kyphoplasty was introduced to realign fractured vertebrae and improve kyphosis,[14] but cost became another concern that could not be overlooked.

Simple postural reduction has been reported to restore anterior body height successfully in patients with vertebral compression fracture.[15,16] The literature shows the vertebral compression fracture to have demonstrated a property of dynamic mobility.[17,18] It helped to restore anterior body height to an increase of 106% compared with initial body height in patients who underwent postural reduction with bolstering followed by vertebroplasty.[17] Furthermore, the anterior longitudinal ligament is usually intact in cases of osteoporotic vertebral compression fracture.[19] Thus, when applying a soft bolster under the vertebrae in question and maintaining the patient in the hyperextended supine position, the ligamentotaxis effect may help the collapsed vertebrae to re-expand and decrease the kyphosis angle.

The purpose of this study was to compare the effects in pain relief, body-height restoration, and kyphosis correction between patients receiving postural reduction by soft pillow and those who do not, prior to vertebroplasty.

2. Materials and methods

2.1. Patient selection

We gathered our patients who had received vertebroplasty between November 2008 and November/December 2010. Their complete history and radiography, including their X-ray and results of magnetic resonance imaging (MRI) scans, were obtained. A kidney, ureter, and bladder (KUB), L-spine lateral view, and L-spine dynamic view were conducted for all patients prior to admission. After a comprehensive review of the patient data, patients with multiple level compression fracture or pathological fracture were excluded. The history of the remaining patients was examined and only the patients whose pain onset occurred more than 6 weeks earlier were included. Their MRI image was then carefully surveyed to confirm the diagnosis of vertebral compression fracture.

2.2. Postural reduction prior to vertebroplasty

Between 2008 and 2010, we intended to use the soft pillow as a tool to re-expand the collapsed vertebra and then proceeded with vertebroplasty as of June 2009. Postural reduction with a pillow was conducted with the patient lying in the supine position, and a soft pillow was placed under the region of the collapsed vertebra (Fig. 1). This maneuver resulted in a hyperextension position over the thoracolumbar spine to try to maintain the correction of kyphosis. The benefits of pillow reduction and possible pain due to the hyperextended position were well explained by our team doctors. During the first interview of patients in our inpatient department, pillow reduction was introduced and explained comprehensively. It was performed only with their full understanding and agreement. Once the patients gave their informed consent, the pillow reduction was done the night prior to vertebroplasty, provided the patients could tolerate it. The following day, patients were transferred to the operating room and percutaneous vertebroplasty was performed under local anesthesia using the technique of unipedicular injection. Postoperative radiography of KUB and the L-spine lateral view were then obtained after the surgery. After the vertebroplasty, the patients had 3–4 hours of bed rest. Thereafter, patients were free to be discharged. External bracing was suggested for 2–3 months.

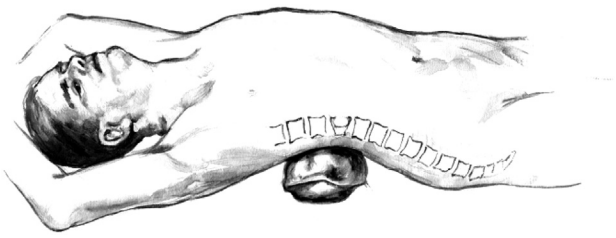

Fig. 1. Patient was put in the supine position, and a soft pillow was put in place to produce a hyperextended position.

2.3. Grouping and assessment

All the demographic data were collected. Patients included in our study were grouped into either Group A or Group B based on whether or not pillow reduction was conducted, respectively. The efficacy of vertebral height re-expansion was evaluated by calculating the compression ratio (i.e., anterior height/posterior height). The sagittal alignment was assessed by Cobb method (i.e., the angle between the superior end plate of one level above the fracture level and the inferior end plate of one level below the fracture level). Patients in each group were further divided into subgroup 1 or subgroup 2 according to their severity of body collapse using their preoperative compression ratio. Patients with a preoperative compression ratio < 0.4 were included in subgroup 1 as their body collapse was more severe with a loss of more than 60% of their anterior body height. Otherwise, they were grouped in subgroup 2 representing patients with a more intact anterior column of the vertebrae. The compression ratio and Cobb angle were compared in each group and subgroup preoperatively and postoperatively to evaluate the efficacy of re-expansion and kyphosis correction. Intraoperative use of cement volume and postoperative complication was reviewed. As part of the outcome measurements, a visual analog scale (VAS)[20] was used to evaluate the result of pain relief. Statistical analysis was performed using the Student *t* test with a confidence interval of 95%.

3. Results

The 46 patients enrolled in our study included 13 males and 33 females. The mean age of patients was 77.4 ± 5.95 years. The duration between pain onset and operation was 63.2 days (approximately 40–250 days). The most common site of fracture was L1 (16 patients, 34.8%) followed by L2 (9 patients, 19.6%), and T12 (8 patients, 17.4%). The 46 patients were divided between Group A and Group B on the basis of whether they were receiving pillow reduction or not. Group A included 24 patients, whereas Group B included 22 patients. The patients in each group were divided further into subgroup 1 or subgroup 2 based on their severity of body collapse, as mentioned previously. There were 10, 14, 9, and 13 patients in A-1, A-2, B-1, and B-2, respectively.

The radiographic and clinical results are demonstrated in Table 1. The duration between pain onset and vertebroplasty was 74.6 ± 21.2 and 55.2 ± 19.6 days in Group A and Group B, respectively, and showed no significant difference. The initial mean compression ratio was 0.48 ± 0.18 and 0.51 ± 0.18 in Group A and Group B, respectively. It was increased to 0.76 ± 0.14 and

Table 1
There was no significant difference in the preoperative and postoperative compression ratios and Cobb angle between Group A and Group B.

Group		A	B	*p*
Duration (d)	Pain onset to VP	74.6 ± 21.2	55.2 ± 19.6	0.18
Preoperative	Compression ratio	0.48 ± 0.18	0.51 ± 0.18	0.62
	Cobb angle	20.2 ± 6.8	19.1 ± 7.7	0.6
	VAS	7.5 ± 1.06	8.0 ± 1.15	0.14
Postoperative	Compression ratio	0.76 ± 0.14	0.71 ± 0.20	0.38
	Cobb angle	6.6 ± 3.1	9.4 ± 7.9	0.13
	VAS	1.9 ± 0.8	1.7 ± 0.65	0.21
	Cement volume	4.3 ± 1.38	4.1 ± 1.48	0.51

d = days; VAS = visual analog scale; VP = vertebroplasty.

0.71 ± 0.20 after vertebroplasty. The preoperative Cobb angle was 20.2° ± 6.8° and 19.1° ± 7.7° in Group A and Group B, respectively, which decreased to 6.6° ± 3.1° and 9.4° ± 7.9° after vertebroplasty. The compression ratio and kyphosis angle revealed significant improvement after vertebroplasty. However, the ratio and angle showed no significant difference between Group A and Group B postoperatively, which demonstrated that the efficacy of pillow reduction was not remarkable. Nevertheless, patients were grouped further into subgroup 1 or subgroup 2 according to the preoperative compression ratio. Significant advantage of height restoration and kyphosis correction was demonstrated in the patients with more severe height loss who underwent pillow reduction. In Table 2, patients were divided further into one of the following groups: A-1, A-2, B-1, and B-2. Among the members of Group A-1 and Group B-1 who had more loss of vertebral body height, patients in Group A-1 who received pillow reduction revealed significantly more improvement in vertebral height restoration and kyphosis correction than did patients in Group B-1 ($p < 0.05$) (Fig. 2). However, patients in subgroup 2 did not demonstrate this difference in height restoration and kyphosis correction among patients with and without pillow reduction.

The volume of cement used did not result in significant difference between the two groups. Neither wound infection nor any new-onset neurological deficit was found in our study. Cement leakage on the postoperative radiography was noted in three cases in Group A and in two cases in Group B. Clinically, all patients had significant pain relief with VAS improving from 7.5 ± 1.06 and 8 ± 1.15 to 1.9 ± 0.8 and 1.7 ± 0.65 in Group A and Group B, respectively.

4. Discussion

Recently, vertebroplasty has been accepted as an effective and safe treatment modality for osteoporotic vertebral compression fractures. In appropriately selected patients, vertebroplasty could provide a means for rapid pain relief and rehabilitation while patients await the later medical treatment for osteoporosis. In most patients with vertebral compression fracture, their pain could be relieved by analgesics, physical therapy, and brace protection in acute phases. Rousing et al reported a clinical randomized study to compare the effects of conservative treatment and vertebroplasty on patients with acute/semiacute osteoporotic vertebral compression fracture.[21] They found that the majority of fractures healed after 8–12 weeks of conservative treatment and comparable pain relief with vertebroplasty. Thus, we chose patients with chronic compression fracture as our candidates for vertebroplasty due to the effective clinical result reported in the literature.[22] However, this procedure was found to have limitations in terms of vertebral body height restoration and kyphosis correction. Thus, kyphoplasty was introduced as a modified technique. Although it can restore height in a compressed body, a substantial difference exists in the cost of kyphoplasty and vertebroplasty. The cost of kyphoplasty is 10–20 times more than vertebroplasty in the United States.[23] In other countries, this difference could be even larger.

The effectiveness of postural reduction in patients with acute thoracolumbar facture was reported in previous studies.[16] Bedbrook reported that thoracolumbar spine injury could be best treated and reduced by this closed method when satisfactory alignment could be obtained.[15] Postural reduction could similarly be effective in patients with osteoporotic vertebral compression fracture because their injury mechanism is usually flexion–compression. This results in a compressed anterior column with relative sparing of the middle and posterior columns and produces an anterior wedge fracture[24] that could be reduced and re-expensed in the supine hyperextended position. The combination of postural reduction and vertebroplasty was reported by Lee and Chen.[25] Postural reduction was performed using the prone position on the operating table after general anesthesia in their study. Closed reduction of the fractured and kyphotic spine was achieved by extending the table to restore the kyphotic angle. Their result showed significant restoration of anterior body height and correction of kyphosis. Postural reduction under the supine position with a soft bolster was reported by Chin et al.[26] They undertook pillow reduction followed by vertebroplasty in 75 patients with vertebral compression fracture and revealed a significant efficacy of height restoration and kyphosis correction. They also reported that the efficacy of pillow reduction in fractures happening more than 8 weeks prior to the procedure is poorer than that in younger fractures. However, McKiernan et al described the dynamic mobility in patients with a mean fracture age of 117 days.[17] They achieved an increase of anterior vertebral height of approximately 106% compared with the initial fracture height and a 40% decrease of the kyphotic angle after applying a soft bolster. In our study, the mean fracture age was 63.2 days, and we had only two cases whose fracture age exceeded 100 days (186 days and 250 days). Among these patients with a fracture age of 2 months, pillow reduction followed by vertebroplasty could restore 28 % ± 10.4% of vertebral height and correct 13.7° ± 5.4° of kyphosis. Thus, vertebral compression fractures in the subacute or chronic phase could be effectively reduced using postural reduction with the hyperextended position.

Generally, a severely collapsed vertebral compression fracture of more than two-thirds of the patient's original height is regarded as a contraindication for vertebroplasty due to technical difficulties.[10,27] Chin and co-workers demonstrated in their study the effectiveness of pillow reduction in a 69-year-old female with a severely compressed vertebral fracture; the fracture was significantly reduced using this method.[26] Percutaneous vertebroplasty was then performed successfully, achieving acceptable body height

Table 2
Comparison of mean compression ratio and Cobb angle between patients in the two groups (four subgroups).[a]

Group/subgroup	A-1[b]	B-1	*p*
Preoperative compression ratio	0.27 ± 0.051	0.32 ± 0.054	0.612
Preoperative Cobb angle	26.5 ± 4.73	24.9 ± 6.49	0.577
ΔCompression ratio	0.36 ± 0.06	0.17 ± 0.48	<0.05
ΔCobb angle	18.1 ± 4.1	8.6 ± 3.2	<0.05
Group/subgroup	**A-2[c]**	**B-2**	***p***
Preoperative compression ratio	0.59 ± 0.14	0.61 ± 0.13	0.82
Preoperative Cobb angle	16.9 ± 6.1	15.1 ± 5.6	0.41
ΔCompression ratio	0.3 ± 0.13	0.26 ± 0.11	0.51
ΔCobb angle	11.9 ± 5.6	10.5 ± 3.8	0.39

[a] In patients in subgroup 1 with a severely compressed vertebral fracture, the efficacy of height restoration and kyphosis correction was significantly better in patients who received pillow reduction than those who did not.
[b] Subgroup 1: Preoperative compression ratio < 0.40.
[c] Subgroup 2: Preoperative compression ratio > 0.40.

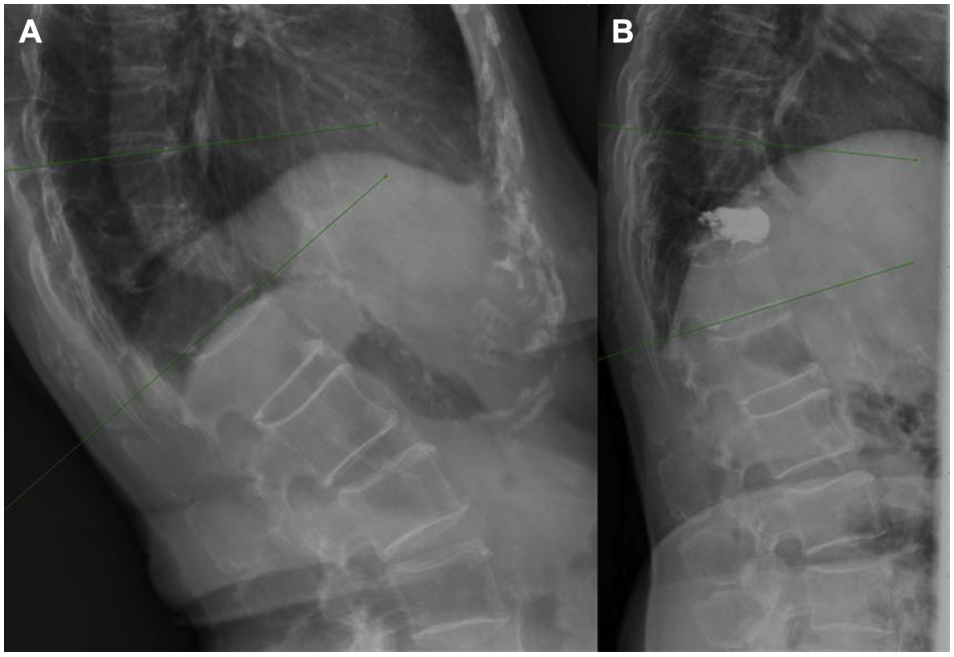

Fig. 2. Anteroposterior and lateral plain films of an 83-year-old woman with a T11 compression fracture who had suffered from intermittent low-back pain for 2 months. (A) Initially, the anterior column of the vertebrae was severely collapsed. The compression ratio was 31.4% and the kyphosis angle was 29.2°. (B) With a postural reduction and subsequent vertebroplasty, the collapsed vertebra was re-expanded and consolidated. The compressed vertebra was restored to 73.2% of its original height, and kyphosis was corrected to 14.5°.

restoration and kyphosis correction. In a study reported by Kim et al that included 18 vertebroplasties following postural reduction with vertebra plana, a 35% restoration of the original body height and correction of 7.0° of kyphosis were achieved.[28] In our study, we could restore height and correct kyphosis by pillow reduction on patients with loss of more than 60% of vertebral body height. Some 36% of height and 18.1° of kyphosis were reduced in patients who underwent pillow reduction. Thus, the severely collapsed vertebrae could be re-expanded by postural reduction to be treated safely and achieve better alignment. In addition, there was a significant difference when comparing the height restoration and kyphosis correction in the subgroup with severely compressed fractures among patients with and without pillow reduction. The height restoration was 36% and 17.2% ($p < 0.05$), and the kyphosis correction was 18.1° and 8.6° ($p < 0.05$) in patients with or without pillow reduction, respectively. However, there was no such significant difference between patients in Group A and Group B in their height restoration and kyphosis correction. Thus, we found that the efficacy of pillow reduction followed by vertebroplasty to realign the spine is more apparent in patients with a severely collapsed compression fracture.

We believe that there is still some limitation inherent in our study. First, it was a retrospective review study. Every clinical intervention, including pillow reduction and vertebroplasty, was not arranged prospectively. Second, our patients were put in a supine position to receive postural reduction but were put in a prone position to accept vertebroplasty. The alteration of the body position should change the effect of pillow reduction, which we could not check in our study. However, the authors of this study believe that this combination of pillow reduction and vertebroplasty offers a simple and cost-effective treatment with better efficacy of realigning the spine than vertebroplasty alone.

In conclusion, postural reduction with a pillow followed by vertebroplasty is a safe and cost-effective treatment modality. It offers better efficacy of vertebral body height restoration and kyphosis correction than vertebroplasty alone in patients with a severely collapsed compression fracture.

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