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Percutaneous Vertebroplasty for Thoracolumbar Osteoporotic Vertebral Compression Fracture (OVCF) in Patients with Distant Lumbosacral Pain

Shanwen Xiao[1*], Shufang Zhou[2], Shixin Pan[1], Guodong Li[1] and Aihui Li[1]

[1]Department of Spine and Orthopedic Surgery, Wuzhou Red Cross hospital, Wuzhou, China
[2]Medical care department for personnel, Wuzhou workers' hospital, Wuzhou, China

Abstract

Objective: A few patients with thoracolumbar Osteoporotic Vertebral Compression Fracture (OVCF) only report pain in the lumbosacral region, which was far from the level of the fractured vertebra. The study aimed to assess the therapeutic efficacy of Percutaneous Vertebroplasty (PVP) in patients with thoracolumbar OVCF who presented with Distal Lumbosacral Pain (DLP), as well as investigate the potential underlying mechanisms of DLP.

Methods: Sixty-nine thoracolumbar OVCF patients who exclusively reported pain in the lumbosacral region of the lower back or buttock were enrolled in the LS group. In a 1:2 ratio, 138 patients who exclusively reported thoracolumbar pain localized at the level of the fractured vertebra were selected for the control group (TL group). Clinical outcomes were evaluated utilizing the Visual Analog Scale (VAS) and Chinese modiied Oswestry Disability Index (CMODI) scores. Radiographic assessment included measurements of vertebral height and Cobb angle.

Results: The VAS and CMODI scores, Cobb angle, and anterior and middle vertebral heights demonstrated significant improvement following surgery in both groups (P<0.05). No significant differences were observed between the two groups in terms of postoperative CMODI scores, Cobb angle, and anterior and middle vertebral heights (P>0.05). However, the LS group exhibited lower preoperative anterior and middle vertebral heights compared to the TL group (P=0.039 and 0.043, respectively). Additionally, there were higher VAS scores at 2 days and 1-month post-operation (both P<0.0001).

Conclusion: Percutaneous Vertebroplasty (PVP) can alleviate pain in the distal lumbosacral area caused by thoracolumbar OVCF. Excessive reduction in vertebral height may pose a potential risk for the emergence of lumbosacral pain. Patients with lumbosacral pain experienced a relatively inferior short-term pain relief following surgery compared to those with thoracolumbar pain.

Keywords: Osteoporotic Vertebral Compression Fracture (OVCF); Distal lumbosacral pain; Lumbosacral pain referred pain; Percutaneous Vertebroplasty (PVP)

Introduction

Osteoporotic Vertebral Compression Fracture (OVCF) seriously affects the quality of life and health of older individuals due to the excruciating pain experienced [1,2]. OVCF occurs primarily in the thoracolumbar region and patients typically complain of back pain in the corresponding fracture area. However, a minority of patients with thoracolumbar OVCF exhibit distinct MRI signals indicating vertebral edema, without acute damage signals to the lumbosacral soft tissue and other structures. These patients report pain in the lumbosacral region, rather than in the thoracolumbar region where the fractured vertebra is located [3]. The lumbosacral pain exhibits relief in a supine position and exacerbation upon standing or walking. Furthermore, this pain re-emerges and intensifies upon tapping the area of the fractured vertebrae. Scholars have referred this phenomenon as "distant pain" [3,4].

Limited research has been conducted on the efficacy of percutaneous kyphoplasty in alleviating this Distal Lumbosacral Pain (DLP) associated with thoracolumbar OVCF [3-6]. However, it remains uncertain whether Percutaneous Vertebroplasty (PVP) also has favorable outcomes for patients experiencing this specific pain pattern. The objective of this study was to evaluate the therapeutic effects of the PVP in patients with thoracolumbar (T11-L2) OVCF, who solely report lumbosacral pain, as well as to investigate the potential pathogenesis of this pain resulting from thoracolumbar OVCF.

Materials and Methods

Between January, 2020 and June, 2022, a group of sixty-nine patients diagnosed with one-level thoracolumbar OVCF exclusively experienced pain localized in the lumbosacral region, specifically around the sacroiliac joint and the iliac crest [3]. It is important to note that these patients did not report any pain localized at the site of the fractured vertebra. Concurrently, a control group comprising 138 patients (selected in a 1:2 ratio) with pain solely in the thoracolumbar region above the level of the fractured vertebra was included. This retrospective study was approved by the institutional review board and ethics committee. Patients voluntarily signed informed consent for the surgery and participated in the study.

***Corresponding author:** Shanwen Xiao, Department of Spine and Orthopedic Surgery, Wuzhou Red Cross hospital, Wuzhou, China, Tel: 86-15277406235, E-mail: xiaoshanwen1@163.com

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Inclusion and exclusion criteria

Patients were included if they met the following criteria: (1) age older than 60 years; (2) preoperative Magnetic Resonance Imaging (MRI) confirmed single-segment thoracolumbar OVCF (T11-L2), that is, a fracture in a vertebral body showing a bone marrow edema signal; (3) pain in thoracolumbar region or lumbosacral region is persistent and worse when changing positions within few weeks, with or without a history of minor injuries (e.g. fall to the floor, bending, stretching); (4) no symptoms of nerve root and/or spinal cord compression; (5) conditions meeting the diagnostic criteria for osteoporosis (World Health Organization), including a L1-L4 bone mineral density T of -2.5 or less on dual-energy x-ray absorptiometry; (6) complete initial and follow-up data [7].

Patients were excluded if they met the following criteria: (1) patients had lumbosacral facial injury with presence of local edema on preoperative Magnetic Resonance (MR): The T1-W image shows low signal intensity, and the T2-W image and T2-W SPAIR image show high signal intensity; (2) congestive flare-up of lumbar facet osteoarthritis, with the presence of liquid in the posterior inter-apophyseal joints on the preoperative MRI; (3) a history of chronic lumbosacral pain (VAS ≥ 3); (4) severe spinal degenerative diseases such as lumbar spondylolisthesis or lumbar spinal stenosis; (5) a history of spinal surgery; (6) other pathological fractures, such as hemangioma, multiple myeloma, and bone tuberculosis; (7) comorbidity with severe cardiovascular and cerebrovascular, respiratory and other medical diseases; and (8) psychological or mental illness [8].

Procedural technique

All operations were performed by 3 experienced spine surgeons using the same method. The patient was positioned prone and the whole procedure was then performed with the aid of a C-arm radiograph. Preoperative vertebral pedicle localization was performed with local anesthesia (1% lidocaine) and unilateral pedicle puncture. When the tip of the puncture needle reached the junction of the middle and anterior third of the affected vertebrae, the puncture was stopped, and the needle core was then withdrawn. After the liquid and power of bone cement ((Polymethyl Methacrylate (PMMA): Sommacampagna, Verona, Italy) mixed complete, the PMMA would be suctioned into a 10 ml screw pressure injector. In order to obtain satisfactory dispersion and to minimize the risk of leakage, all cements were injected during "toothpaste-like" phase after mixing. The cement was injected into the targeted vertebrae using a screw pressure injector under the C-arm fluoroscope. Standard for cement to stop injection: (1) A satisfactorily dispersion and distribution of the cement was achieved, that is, symmetrical filling of the anterior 3/4 part of the vertebral body. (2) The cement reached the posterior 1/4 of the vertebral body. (3) When cement leakage was noted, injection was temporarily halted, and we continued the injection after about one minute, but if there was a reoccurrence of the leakage the injection was terminated.

Postoperative treatment

Patients were allowed to free movement 24 hours after surgery. They were required to wear a waist protector for 1 month when getting out of bed and were advised to have a post-operative reviews at 1,3,6 and 12 months. All patients were routinely administered calcium and active vitamin D supplements for anti-osteoporosis agents (zoledronic acid).

Clinical outcomes

Visual analog scale (VAS, 0-10 points) scores before surgery and 2 days and 1, 3 months after surgery and at the last follow-up time were recorded. Chinese modified Oswestry Disability Index (CMODI) was used for functional assessment. There were changes in the CMODI from the original Oswestry Disability Index (ODI): Considering Chinese people's unwillingness to answer questions about sex, item 8, which addressed the patient's sex life, was removed. Thus, the CMODI contains 9 items with a maximum score of 45. The CMODI scores were recorded before surgery and 3 months after surgery and at the last follow-up.

Radiographic evaluation

Plain radiographs were taken pre-surgery, one day after surgery and the final follow-up with the patient in a standing position. The height of the anterior and middle vertebrae was defined as the distance between the upper and lower endplates at the anterior wall of the vertebrae and at the center of the vertebrae [9]. The Cobb angle between the superior endplate of the adjacent upper vertebra and the inferior endplate of the lower vertebra was used to assess local kyphotic deformity [10]. If the adjacent vertebra was previously fractured, the nearest intact vertebra was used to make an estimation.

Statistical analysis

Statistical analysis were carried out using SPSS 20.0 (IBM Corporation, Armonk, NY). The baseline characteristics of the 2 groups were compared by the independent sample t-test or the $\chi 2$ test. The change from baseline within each group was evaluated using paired t tests for both clinical and radiological outcomes. Differences between the two groups were evaluated using the Mann–Whitney U tests for continuous variables and $\chi 2$ tests for categorical variables. All p values less than 0.05 were considered statistically significant.

Results

A total of 207 patients were included in the study, with 69 patients in the LS group and 138 patients in the TL group. All patients successfully completed the surgical treatment. Baseline characteristics, including bone mineral density, level of fractured vertebra, bone cement injection, and follow-up time, did not differ significantly between the two groups (P>0.05) (Table 1).

Both the VAS and CMODI scores showed significant improvement compared to preoperative scores (P<0.05), (Table 2). There were no significant differences in the VAS and CMODI scores between the LS and TL groups at preoperative, 3 months postoperatively, or at the last follow-up time (P>0.05) (Table 2). However, in comparison to the TL group, the LS group exhibited higher VAS scores at 2 days and 1 month after surgery (both P<0.0001) (Table 2).

The preoperative Cobb angle was comparable in the 2 groups, while the LS group had lower preoperative anterior and middle vertebral heights compared to the TL group (P=0.039 and 0.043, respectively). Both the vertebral heights and Cobb angle showed significant improvement after the surgery. The difference in the anterior and middle vertebral heights and Cobb angle between the two groups at postoperative 2 days or the last follow-up time were not statistically significant (P>0.05) (Table 3).

	TL(N=138)	LS(N=69)	P
Male/Female	13/125	July-62	0.868
Age, years	76.57 ± 7.40	76.12 ± 6.07	0.568
Bone density, T-score	-2.91 ± 0.21	-3.01 ± 0.19	0.712
Level of fractured vertebrae			0.643
T11	12	3	
T12	63	36	
L1	49	23	
L2	14	7	
Bone cement injection (mL)	4.4 ± 1.1	4.7 ± 1.9	0.075
Follow-up time (months)	15.7 ± 3.2	16.2 ± 3.8	0.075

TL: The group of pain in thoracolumbar region; LS: The group of pain in lumbosacral region

Table 1: Comparison of the baseline data between two groups.

	VAS					CMODI		
	Preoperative	Postoperative 2 days	Postoperative 1 month	Postoperative 3 months	Final follow-up	Preoperative	Postoperative 3 months	Final follow-up
TL	7.62 ± 0.73	2.64 ± 0.57	1.93 ± 0.37	1.36 ± 0.50	0.84 ± 0.53	70.15 ± 3.43	27.66 ± 4.48	19.56 ± 2.81
LS	7.67±0.64	3.19 ± 0.55	2.29 ± 0.55	1.43 ± 0.50	0.86 ± 0.63	70.13 ± 2.94	28.42 ± 4.39	20.02 ± 2.85
P	0.659	0.0001	0.0001	0.326	0.869	0.963	0.263	0.295

CMODI: Chinese modified Oswestry Disability Index; TL: The group of pain in thoracolumbar region; LS: The group of pain in lumbosacral region; VAS: Visual Analog Scale

Table 2: Comparison of the clinical outcomes between two groups.

	Anterior vertebral height (mm)			Middle vertebral height (mm)			Cobb angle (°)		
	Preoperative	Postoperative	Final FU	Preoperative	Postoperative	Final FU	Preoperative	Postoperative	Final FU
TL	19.29 ± 3.11	19.53 ± 3.08	19.36 ± 3.10	19.26 ± 3.73	19.55 ± 3.73	19.39 ± 3.73	10.03 ± 2.71	9.11 ± 2.84	8.21 ± 2.85
LS	18.56 ± 1.91	18.98 ± 1.90	18.83 ± 1.90	18.38 ± 2.50	18.81 ± 2.55	18.71 ± 2.56	10.33 ± 2.44	9.06 ± 2.53	8.08 ± 2.73
P	0.039	0.118	0.128	0.043	0.097	0.127	0.436	0.911	0.743

FU: Follow-Up; TL: The group of pain in thoracolumbar region; LS: The group of pain in lumbosacral region

Table 3: Comparison of the radiographic outcomes between two groups.

Discussion

This retrospective study tried to assess the impact of Percutaneous Vertebroplasty on patients with thoracolumbar Osteoporotic Vertebral Compression Fracture (OVCF) who experienced pain either in the lumbosacral region (LS group) or the thoracolumbar region (TL group). The findings revealed that the LS group had lower preoperative anterior and middle vertebral heights compared to the TL group (P=0.039 and 0.043, respectively). Following the surgery, significant improvements were observed in the VAS and CMODI scores, as well as in the anterior and middle vertebral heights and Cobb angle(P<0.05). The LS group exhibited significantly higher VAS scores at both the 2nd day and 1st month postoperative periods (both P<0.0001) compared to the TL group. These findings suggest that Percutaneous Vertebroplasty may provide benefits for patients with thoracolumbar OVCF who experience pain in the lumbosacral or thoracolumbar regions. The presence of vertebral height loss may pose a risk for lumbosacral pain in patients with thoracolumbar OVCF. Additionally, short-term postoperative pain relief may be relatively poor in patients reporting pain in the lumbosacral region compared to those in the thoracolumbar region.

Thoracolumbar OVCFs typically manifest with intense pain in the corresponding region. However, a minority of patients, who have confirmed thoracolumbar OVCF through Magnetic Resonance Imaging (MRI), have reported experiencing Distal Lumbosacral Pain (DLP) instead of localized back pain at the level of the fractured vertebra [3,6]. It is commonly observed that lumbosacral pain in older patients is primarily attributed to degenerative changes in the lumbosacral region [11-13], whereas the association between thoracolumbar OVCF and lumbosacral pain is less frequently documented [6,14]. Li, et al. found that 33.9% of patients suffering from thoracolumbar OVCF experienced pain solely in the distant lumbosacral region, rather than in the immediate vicinity of the fractured vertebra [5]. Given the prevalence of lumbar degenerative changes in the elderly population, these OVCF patients are susceptible to being misdiagnosed with lumbar degenerative diseases [3]. Therefore, when an older individual presents with lumbosacral pain, particularly if there is a history of low-energy trauma, it is imperative to consider the possibility of a thoracolumbar fracture [5]. However, it is important to also rule out any acute damage to the lumbosacral soft tissue and lumbar facet syndrome in these patients.

The etiology of DLP in thoracolumbar OVCF patients remains unclear [3,5,6]. Some scholars propose that this lumbosacral pain may be attributed to vertebrogenic referred pain, which can be explained by the convergence-projection mechanism [5,15,16]. According to this hypothesis, primary afferent nerve fibers originating from distinct anatomical regions converge onto the same secondary neuron within the spinal cord, leading to misidentification of the pain source by the central nervous system [17,18]. Maigne R, et al. proposed that lumbosacral pain could originate in the thoracolumbar joint, mediated by the superior cluneal nerves, which was derived from the cutaneous branches of the dorsal rami of T11–L2 [19-22]. Each of the rami supplied the areas of the lower back, around the sacroiliac joint and the iliac crest. Niu J, et al. considered that thoracolumbar vertebral fractures with surrounding soft tissue and facet joint injury may stimulate the sympathetic ganglion or dorsal ramus of T11-L2, which leading to the referred DLP [3] Niu J, et al. posited that the reduction in vertebral height resulted in the constriction of the intervertebral foramen, thereby causing irritation to the posterior branches of the spinal nerves at T12,L1 and L2. The present study observed that the preoperative anterior and middle vertebral heights were significantly lower in the LS group compared to the TL group (P=0.039 and 0.043, respectively) [23]. This finding implies that an excessive collapse of vertebral height may potentially contribute to lumbosacral pain in patients with thoracolumbar OVCF.

There were few studies reported that percutaneous kyphoplasty could alleviate the DLP [3-6]. The results of this study showed significant improvements in the Cobb angle, anterior vertebral heights, VAS and CMODI after surgery. These outcomes can be attributed to the ability of PVP to restore vertebral height, eliminate micro-motion within the fractured vertebra, and alleviate the mechanical load exerted on the facet joints. Consequently, these factors collectively contribute to the reduction of irritation or compression on the sympathetic ganglion or dorsal ramus [3]. The LS group had higher VAS scores at both the 2nd day and 1st month postoperative periods compared to the TL group. These findings suggest that patients with lumbosacral pain may experience inferior short-term pain relief following surgery compared to those with thoracolumbar pain, and this information should be communicated to patients before surgery.

Conclusion

Percutaneous vertebroplasty can alleviate pain in the distal lumbosacral area caused by thoracolumbar OVCF. Excessive reduction in vertebral height may pose a potential risk for the emergence of lumbosacral pain. Patients with lumbosacral pain experienced a relatively inferior short-term pain relief following surgery compared to those with thoracolumbar pain.

Limitations

This retrospective study had several limitations. Firstly, it was conducted at single hospital with a limited number of patients, which may have introduced bias due to the limited number of patients included. Secondly, the measurement of intervertebral foramen height was not performed. Therefore, large-scale and well-designed RCTs are necessary to generate high-quality evidence in the future.

Declarations

Ethics approval and consent to participate

This clinical study was approved by the medical ethics committee of Wuzhou Red Cross Hospital. This study also followed the guidelines of good clinical practice and the Helsinki declaration. Informed consent was obtained from all the patient.

Consent for publication

Not applicable

Competing interests

The authors reported no relevant financial or non-financial interests to disclose.

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Authors' contributions

All authors contributed to the conception and design of the research. Material preparation, data collection and analysis were performed by Shanwen Xiao, Shufang Zhou, and Shixin Pan. The first draft of this manuscript was written by Shanwen Xiao, with revisions contributed by Guodong Li and Aihui Li. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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References

1. Salari N, Ghasemi H, Mohammadi L, Behzadi MH, Rabieenia E, et al. (2021) The global prevalence of osteoporosis in the world: A comprehensive systematic review and meta-analysis. J Orthop Surg Res 16:609.
2. Zhou C, Liao Y, Chen H, Wang Y (2023) Analysis of optimal volume fraction percentage and influencing factors of bone cement distribution in vertebroplasty using digital techniques. J Orthop Surg Res 18:235.
3. Niu J, Song D, Gan M, Liu B, Tan C, et al. (2018) Percutaneous kyphoplasty for the treatment of distal lumbosacral pain caused by osteoporotic thoracolumbar vertebral fracture. Acta Radiol 59:1351-1357.
4. Yang YM, Ren ZW, Ma W, Jha RK (2014) Kyphoplasty for the treatment of pain distant to osteoporotic thoracolumbar compressive fractures. Cell Biochem Biophys 68:523-527.
5. Li Y, Feng X, Pan J, Yang M, Li L, et al. (2021) Percutaneous vertebroplasty *versus* kyphoplasty for thoracolumbar osteoporotic vertebral compression fractures in patients with distant lumbosacral pain. Pain Physician 24:E349-E356.
6. Fang YP, Lu YJ, Gan MF, Shen X, Lu D (2021) Percutaneous kyphoplasty for a patient of thoracolumbar osteoporotic vertebral compression fractures with distal lumbosacral pain: A case report. Ann Palliat Med 10:4944.
7. Randall S, Cosman F, Beur S, Leboff MS, Lindsay R, (2014) Clinician's guide to prevention and treatment of osteoporosis. Osteoporosis international: A journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA 33:2049-102.
8. Yan Y, Xu R, Zou T (2015) Is thoracolumbar fascia injury the cause of residual back pain after percutaneous vertebroplasty?: A prospective cohort study. Osteoporosis International 26:1119-24.
9. McKiernan F, Faciszewski T, Jensen R (2003) Reporting height restoration in vertebral compression fractures. Spine 28:2517-2521.
10. Phillips FM, Ho E, Campbell-Hupp M, McNally T, Todd WF, et al. (2003) Early radiographic and clinical results of balloon kyphoplasty for the treatment of osteoporotic vertebral compression fractures. Spine 28:2260-2265.
11. Lo YL, Fook-Chong S, Huerto AP, George JM (2011) A randomized, placebo-controlled trial of repetitive spinal magnetic stimulation in lumbosacral spondylotic pain. Pain Med 12:1041-1045.
12. Muraki S, Oka H, Akune T, Mabuchi A, En-Yo Y, et al. (2009) Prevalence of radiographic lumbar spondylosis and its association with low back pain in elderly subjects of population-based cohorts: The ROAD study. Osteoarthritis & Cartilage 17:1137-1143.
13. Toyone T, Takahashi K, Kitahara H, Yamagata M, Murakami M, et al. (1994) Vertebral bone-marrow changes in degenerative lumbar disc disease: An MRI study of 74 patients with low back pain. Journal of Bone & Joint Surgery British Volume 76:757.
14. Fang YP, Lu YJ, Gan MF, Shen X, Lu D (2020) Percutaneous kyphoplasty for a patient of thoracolumbar osteoporotic vertebral compression fractures with distal lumbosacral pain. Ann Palliat Med 9:48.
15. Shi R, Chen T, Liang J (2019) Clinical classification and treatment of somatic referred pain of osteoporotic vertebral compression fracture. J Pract Orthop 25:201-4.
16. Gibson JE, Pilgram TK, Gilula LA (2006) Response of nonmidline pain to percutaneous vertebroplasty. Am J Roentgenol 187:869-872.
17. Fujii T, Sakuma Y, Orita S, Inoue G, Ochiai N, et al. (2013) Dichotomizing sensory nerve fibers innervating both the lumbar vertebral body and the area surrounding the iliac crest: A possible mechanism of referred lateral back pain from lumbar vertebral body. Spine 38:E1571.
18. Sameda H, Takahashi Y, Takahashi K, Chiba T, Ohtori S, et al. (2003) Dorsal root ganglion neurones with dichotomising afferent fibres to both the lumbar disc and the groin skin. A possible neuronal mechanism underlying referred groin pain in lower lumbar disc diseases. J Bone Joint Surg Br 85:600-603.
19. Maigne R (1981) The thoraco-lumbar junction syndrome: Low-back pain, pseudo-visceral pain, pseudo-hip pain and pseudo-pubic pain (author's transl). Sem Hop 57:545-554.
20. Maigne R (1980) Low back pain of thoracolumbar origin. Arch Phys Med Rehab 61:389-395.
21. Iwanaga J, Simonds E, Patel M, Oskouian RJ, Tubbs RS (2018) Anatomic study of superior cluneal nerves: Application to low back pain and surgical approaches to lumbar vertebrae. World Neurosurg 116:e766-e768.
22. Aoun F, Malek E, Kazan D, Albisinni S, Peltier A, et al. (2020) Management of chronic testicular pain due to thoracolumbar junction syndrome: A pilot study. Prog Urol 30:114-118.
23. Doo TH, Shin DA, Kim HI, Shin DG, Kim HJ, et al. (2008) Clinical relevance of pain patterns in osteoporotic vertebral compression fractures. J Korean Med Sci 23:1005-1010.