Clinical study of unilateral Percutaneous vertebra plasty(PVP) in the treatment of Osteoporotic vertebral compression fractures(OVCF) in the elderly

Lu Dongyan Qin Chuqiang Yang Bo Liu Huiyi Kou Chenxin

Department of Orthopedics, the Third Affiliated Hospital of Guangzhou Medical University Guangzhou 510150, China

Lu Dong-yan, Email:664601131@qq.com, <https://orcid.org/0000-0003-0728-3026>

Article History Received 9 August 2020 Accepted 25 December 2020 Published 31 December 2020

Cite this Article Lu Dongyan, Qin Chuqiang, Yang Bo ,Liu Huiyi ,Kou Chenxin. Clinical study of unilateral Percutaneous vertebra plasty(PVP) in the treatment of Osteoporotic vertebral compression fractures(OVCF) in the elderly [J].Medical Research, 2020.2(4):1-9, [http://dx.doi.org/10.6913/MRHK.202012_2\(4\).0001](http://dx.doi.org/10.6913/MRHK.202012_2(4).0001)

Copyright © 2020 Creative Publishing Co., Limited. All rights reserved. Email:mrhk26640333@gmail.com.

ABSTRACT

Objective To study the clinical effect of unilateral percutaneous vertebra plasty (PVP) in the treatment of osteoporotic lumbar compression fracture (OVCF) in the elderly.

Methods 84 elderly patients with OVCF who were treated in our hospital from January 2017 to December 2020 were included and divided into unilateral group (n=42) and bilateral group (n=42) according to the random number table method. Unilateral PVP treatment was performed in the unilateral group, and bilateral PVP treatment was performed in the bilateral group. Observed two groups of X-ray machine, bone cement dosage irradiation time and operation time indicators such as surgery, preoperative and postoperative and postoperative convex Cobb Angle, after 1 years of vertebral body lesions vertebral body height and body function, preoperative and postoperative 7d and postoperative pain degree and 1 year serum Norepinephrine (NE) and Serotonin (5-HT) and Substance P (SP) and so on pain factor levels, postoperative complications and other indicators;

Results the time of X-ray machine irradiation, amount of bone cement and operation time in the unilateral group were all lower than those in the bilateral group ($P<0.05$). After surgery and 1 year after surgery, there was no difference in Cobb Angle of kyphotic vertebra, height of diseased vertebra and limb function between the two groups ($P>0.05$). There was no difference in VAS scores and 5-ht, SP and NE levels between the two groups after and 1 year after surgery ($P>0.05$). The incidence of postoperative complications in the unilateral group (19.05%) was lower than that in the bilateral group (47.62%) ($P<0.05$).

Conclusion unilateral PVP can achieve the same effect as bilateral PVP in the treatment of elderly OVCF. Small trauma, easy to operate, can effectively relieve patients' pain, safe and reliable, worthy of clinical

recommendation.

Keywords Unilateral Percutaneous vertebra plasty; Old age; Osteoporotic vertebral compression fractures; Bone cement; Pain factor

Osteoporotic lumbar compression fracture (OVCF) is a common complication of osteoporosis (OP), which occurs mostly in the elderly. It is clinically manifested as low back pain, kyphosis and other symptoms. In severe cases, it can lead to paralysis [1]. In recent years, as my country's aging level continues to increase, the incidence of OVCF has also shown an increasing trend. For OVCF, there have been multiple palliative treatments such as bed rest, drug treatment, and bracing. Although the above treatment can improve symptoms, it is often prone to muscle atrophy and accelerated bone loss, triggering a vicious circle [2]. Percutaneous vertebroplasty (PVP) can effectively restore the height of the vertebral body, improve the stability of the vertebral body, and increase the strength of the vertebral body. It has become an important surgical procedure for the clinical treatment of OVCF, but there is still some controversy about the choice of approach [3]. Our hospital applied unilateral PVP to the clinical treatment of elderly OVCF patients from January 2015 to December 2017, and the results were satisfactory. The report is as follows.

1 Materials and methods

1.1 The clinical data included 84 elderly OVCF patients treated in our hospital from January 2017 to December 2020, including 49 males (58.33%) and 35 females (41.67%); aged 60-87 years old, Average (68.75±6.94) years old; BMI 20.27~23.79kg/m², average (22.52±2.39) kg/m²; disease course 1-7d, average (3.86±0.39) d; fracture segment: T1123 cases (27.38%) , T1235 cases (41.67%), L117 cases (20.24%), L29 cases (10.71%); Genant scale: I degree 25 cases (29.76%), II degree 39 cases (46.43%), III degree 20 cases (23.81) %; Bone density: 0.48~0.69g/cm², average (0.62±0.08)g/cm². Inclusion criteria: patients with OVCF diagnosed by imaging and bone density examination; patients with intact posterior wall of the injured vertebra and intact nerve roots and spinal cord; patients with fresh fractures; patients with informed consent; patients with good compliance; patients with ineffective palliative treatment . Exclusion criteria: patients with old and pathological OVCF; patients with congenital spinal deformity, spinal stenosis, ankylosing spondylitis, bone tuberculosis, and bone tumors; patients with PVP and anesthesia contraindications; patients with surgical intolerance; combined with important organ dysfunction Patients; patients with abnormal immune mechanisms. According to the random number table method, 84 elderly OVCF patients were divided into unilateral group (n=42) and bilateral group (n=42). There was no difference in baseline data between the two groups (P>0.05). (Table 1)

1.2 Method

1.2.1 Unilateral group Unilateral group of unilateral PVP treatment. The patient was subjected to local anesthesia and prone position, and the injured vertebra and its pedicle were positioned under the C-arm X-ray machine. After positioning, cut from the skin to the injured vertebrae in turn, puncture the upper edge of the

transverse process of the injured vertebrae, about 6 cm next to the spinous process, puncture to the anterior 1/3 of the vertebral body, pull out the needle core, prepare the bone cement, and place it on the C arm Slowly inject the injured vertebral body under the X-ray machine and make it evenly dispersed, observe the bone cement, pull out the puncture needle and suture the incision after it has solidified. Routine postoperative treatment.

Table 1 Comparison of baseline data between the two groups

normal information	Unilateral group (n=42)	Bilateral group (n=42)	χ^2/t	P
gender (male/female)	23/19	26/16	0.4356	0.5093
age (years)	68.41±6.90	68.80±6.98	0.2575	0.7974
BMI (kg/m ²)	22.47±2.35	22.56±2.44	0.1722	0.8637
Course of disease (d)	3.89±0.42	3.84±0.35	0.5927	0.5550
injury segment (T11/T12/L1/L2)	11/18/8/5	12/17/9/4		
Genant indexing (I degree/II degree/III degree)	12/18/12	13/21/8		
bone density (g/cm ²)	0.63±0.09	0.61±0.07	1.1368	0.2589

1.2.1 Unilateral group Unilateral group of unilateral PVP treatment. The patient was subjected to local anesthesia and prone position, and the injured vertebra and its pedicle were positioned under the C-arm X-ray machine. After positioning, cut from the skin to the injured vertebrae in turn, puncture the upper edge of the transverse process of the injured vertebrae, about 6 cm next to the spinous process, puncture to the anterior 1/3 of the vertebral body, pull out the needle core, prepare the bone cement, and place it on the C arm Slowly inject the injured vertebral body under the X-ray machine and make it evenly dispersed, observe the bone cement, pull out the puncture needle and suture the incision after it has solidified. Routine postoperative treatment.

1.2.1 Bilateral group Bilateral PVP treatment was performed in the bilateral group. The operation before incision and incision is the same as the unilateral group. Puncture the pedicles of both sides in turn, puncture to the midpoint of the injured vertebral body, and then inject bone cement under the C-arm X-ray machine on both sides of the injured vertebra.

1.3 Observation indexes

Observe the operation indexes such as X-ray machine irradiation time, bone cement dosage and operation time in the two groups. Preoperative, postoperative, and 1 year postoperative kyphotic Cobb angle, height of the diseased vertebral body, and limb function; preoperative, postoperative 7 days and 1 year postoperative pain, serum norepinephrine (NE), serotonin (5-HT), substance P (SP) and other pain factors; postoperative complications and other indicators. Limb function was evaluated by Oswestry dysfunction index (ODI); pain degree was evaluated by visual analog scale (VAS); pain factor was detected by

fluorescence spectrophotometry.

1.4 Statistical methods Data are analyzed by SPSS19.0 statistical software, quantitative data are described by ($\bar{x} \pm s$), paired t test is performed for comparison within groups, and independent sample t test is performed for comparison between groups; qualitative data are expressed as percentages of cases, between groups Comparison line χ^2 test. The inspection level α was 0.05.

2 Results

2.1 Comparison of operation indexes between the two groups The X-ray machine irradiation time, bone cement dosage and operation time in the unilateral group were all smaller than those in the bilateral group ($P < 0.05$). (Table 2)

Table 2 Comparison of surgical indicators between the two groups ($\bar{x} \pm s$)

Index	Unilateral group (n=42)	Bilateral group (n=42)	t	P
X-ray machine irradiation time (min)	11.86±1.24	20.95±2.18	23.4889	0.0000
Bone cement dosage (mL)	3.58±0.37	6.02±0.63	21.6434	0.0000
Operation time (min)	33.87±2.42	47.25±4.82	16.0775	0.0000

Table 3 Comparison of Cobb angle, height of vertebral body and limb function of kyphosis between the two groups ($\bar{x} \pm s$)

Index	Time	unilateral group (n=42)	bilateral group (n=42)	t	P
Cobb angle of kyphosis (°)	Preoperative	21.07±2.24	21.11±2.27	0.0813	0.9354
	Postoperative	14.85±1.62	14.68±1.59	0.4854	0.6287
	1 year after operation	15.93±1.68	15.75±1.66	0.4939	0.6227
Height of diseased vertebral body (mm)	Preoperative	18.67±1.95	18.62±1.93	0.1181	0.9063
	Postoperative	22.68±2.34	22.73±2.37	0.0973	0.9227
	1 year after operation	21.78±2.24	22.16±2.30	0.7671	0.4452
ODI	Preoperative	42.97±4.35	42.93±4.31	0.0423	0.9663
	Postoperative	34.96±3.54	33.78±3.50	1.5362	0.1283
	1 year after operation	19.46±2.06	18.87±1.97	1.3415	0.1835

2.2 Comparison of Cobb angle, height of kyphotic vertebral body and ODI between the two groups before operation, there was no difference between the two groups of Cobb angle, height of kyphotic vertebral body and ODI ($P > 0.05$); postoperative and postoperative 1 Years, the Cobb angle and ODI of the kyphotic vertebrae in the two groups were smaller than before the operation, and the height of the diseased vertebral body was greater than that before the operation ($P < 0.05$); 1 year after the operation, the Cobb angle of the kyphotic

vertebrae in the two groups was greater than that after the operation The height of the diseased vertebral body was less than that after the operation ($P<0.05$); after the operation and 1 year after the operation, there were no differences in the Cobb angle, the height of the diseased vertebral body and the limb function between the two groups ($P>0.05$). (Table 3)

2.3 Comparison of VAS scores and pain factors between the two groups Before surgery, there was no difference in VAS scores and 5-HT, SP, NE levels between the two groups ($P>0.05$); after surgery and 1 year after surgery, the two groups had VAS scores and 5-HT The levels of, SP and NE were lower than before operation ($P<0.05$); 1 year after operation, the VAS scores and 5-HT, SP, NE levels of the two groups were lower than those after operation ($P<0.05$); 1 year after operation and 1 year There was no difference in VAS scores and 5-HT, SP, NE levels between the two groups ($P>0.05$). (Table 4)

Table 4 Comparison of VAS scores and pain factors between the two groups ($\bar{x}\pm s$)

Index	Time	Unilateral group (n=42)	Bilateral group (n=42)	<i>t</i>	<i>P</i>
VAS score (points)	preoperative	8.29±0.84	8.18±0.82	0.6073	0.5453
	7- day after operative	5.46±0.55 ^a	5.50±0.56 ^a	0.3303	0.7420
	1-year after operative	1.92±0.19 ^{ab}	1.90±0.21 ^{ab}	0.4577	0.6484
5-HT (μmol/mL)	preoperative	0.93±0.12	0.90±0.10	1.2447	0.2168
	7- day after operative	0.82±0.08 ^a	0.85±0.09 ^a	1.6146	0.1102
	1-year after operative	0.20±0.04 ^{ab}	0.19±0.02 ^{ab}	1.4491	0.1511
NE (pg/mL)	preoperative	5.42±0.56	5.39±0.55	0.2477	0.8050
	7- day after operative	4.67±0.48 ^a	4.70±0.49 ^a	0.2834	0.7776
	1-year after operative	1.46±0.16 ^{ab}	1.42±0.15 ^{ab}	1.1820	0.2406
SP (ng/mL)	preoperative	249.85±25.66	241.62±25.18	1.4836	0.1418
	7- day after operative	204.78±21.33 ^a	212.18±21.36 ^a	1.5887	0.1160
	1-year after operative	49.86±5.13 ^{ab}	48.38±5.09 ^{ab}	1.3272	0.1881

Note: Compared with preoperatively, ^a $P<0.05$; compared with 7d after operation, ^b $P<0.05$.

2.4 Comparison of postoperative complications between the two groups. The incidence of postoperative complications in the unilateral group (19.05%) was lower than that in the bilateral group (47.62%) ($P<0.05$). (Table 5)

3 Discussion

Trabecular bone is the main structure of the vertebral body. When the vertebral body is under pressure, the compressive force can be transmitted to the vertebral endplate through the intervertebral disc, and finally

Table 5 Comparison of postoperative complications between the two groups [n (%)]

Index	Unilateral group (n=42)	Bilateral group (n=42)	χ^2	P
Infection	1 (2.38)	2 (4.76)		
hematoma	2 (4.76)	3 (7.14)		
spinal nerve injury	2 (4.76)	6 (14.29)		
bone cement leakage	3 (7.14)	9 (2.14)		
Total	8 (19.05)	20 (47.62)	7.6224	0.0058

transmitted to the trabecular bone, which spreads to the surroundings, and in the vertebral body. Stress is generated in the body to avoid damage to the vertebral body [4]. If the stress is too large, it is easy to cause damage to the trabecular bone structure and cracks. If the cracks continue to increase, it can lead to fractures [5]. Osteoporosis can significantly reduce the bone density of trabecular bone, resulting in changes in its shape, structure and function. If it encounters a strong compression force, it can lead to OVCF [6]. PVP can repair trabecular bone cracks by injecting bone cement, restore the height of the injured vertebral body and the kyphotic Cobb angle, improve the stiffness and strength of the injured vertebra, and achieve the purpose of treatment [7]. Regarding the choice of PVP surgical approach, previous studies believed that bilateral PVP can effectively avoid dura mater and nerve root damage, bone cement fully fills the fracture site, and the distribution is more uniform, and the spine is not easy to tilt to one side after surgery [8]. However, unilateral PVP is prone to uneven bone cement infusion, and unilateral weight bearing after surgery often leads to spinal imbalance and tilt to one side [9]. However, recent studies have shown that for OVCF patients, unilateral PVP can achieve the same curative effect as bilateral PVP, and unilateral PVP has the advantages of operation time, radiation exposure time, number of punctures, less bone cement consumption, and less trauma [10]. Elderly patients often suffer from respiratory and circulatory diseases, and it is often difficult to lie prone for a long time. Unilateral PVP is more helpful to reduce the perioperative risk [11]. In this study, the X-ray machine irradiation time, bone cement dosage, and operation time in the unilateral group were shorter than those in the bilateral group. After surgery and 1 year after surgery, the two groups of kyphotic Cobb angle, the height of the diseased vertebra and the limbs There is no difference in function, indicating that unilateral PVP has certain advantages in treating elderly OVCF compared with bilateral PVP. Vertebral microfractures are the main cause of OVCF pain [12]. Studies have shown that micro-fractures of the vertebral body can lead to changes in the mechanical stress of the vertebral body and local inflammatory reactions, stimulating or compressing the nerves and causing pain [13]. PVP can repair microfractures of the vertebral body, reduce mechanical stress, relieve inflammatory reactions, thereby reduce nerve compression and stimulation, and relieve or relieve pain [14]. In this study, the postoperative VAS scores and pain factor levels of the two groups of patients were significantly reduced, and there was no difference between the groups, indicating that both surgical methods

can repair microfractures by injection of bone cement and correct the mechanical stress imbalance of the vertebral body. Although the bilateral group can fill the fracture gap of the injured vertebral body, its pain relief effect is not significant compared with the unilateral group. The main reason is that a large amount of bone cement can increase the local pressure, causing the bone cement to flow along the gap in the vertebral body. Leakage, and the greater the injection volume, the higher the probability of leakage ^[15]. In addition, bilateral PVP is punctured on both sides, which is more traumatic and is very prone to complications such as infection, hematoma and spinal nerve injury. In order to improve the efficiency of puncture, it is necessary to conduct a comprehensive evaluation of the patient before the operation, accurately grasp the imaging characteristics of the fracture position, and puncture the severely injured vertebral body under the guidance of the C-arm X-ray machine during the operation ^[16]. If the degree of compression on both sides is the same, puncture on the larger side of the pedicle. If the pedicle of the thoracic spine is small, the transverse costal approach can be chosen ^[17]. The needle entry point should be slightly outside, and the abduction angle should be increased appropriately. If the lateral X-ray machine indicates that the puncture needle has reached the posterior edge of the vertebral body, at this time, the orthographic X-ray machine cannot pass through the inner edge of the pedicle to avoid nerve damage ^[18]. When injecting bone cement, a uniform rate and low pressure bolus injection is required, and each injection needs to be less than 0.5mL, and pay close attention to its dispersion. If the bolus injection is blocked and bone cement leakage is found, it is necessary to stop the bolus injection and pull the push rod back slightly, and start to inject at a uniform rate after 1 min ^[19]. The bolus injection should be started as far as possible on the front of the vertebral body, so that the bone cement gradually diffuses from the front to the back of the vertebral body. When injecting bone cement, it is not necessary to pursue the amount of injection to avoid leakage into the spinal canal, causing serious consequences ^[20]. In order to maintain the height of the vertebral body for a long time, in addition to ensuring that the bone cement is dispersed on both sides of the coronal surface of the injured vertebra, it is also necessary to ensure that the bone cement is dispersed on the sagittal plane of the injured vertebrae to achieve good support and Fixation ^[21]. 4 Summary In summary, unilateral PVP treatment of elderly OVCF can effectively restore the height of the injured vertebral body and the kyphotic Cobb angle, improve the stiffness and strength of the injured vertebra, and the effect is the same as that of bilateral PVP. In addition, it is less traumatic and easy to operate. It can effectively reduce the generation of pain factors, relieve the pain of patients, and has a low incidence of postoperative complications. It is worthy of clinical recommendation.

References

- [1]Kang JH, Yang SM, Im SB, et al. Can Three Months of Teriparatide Be One of Treatment Options for Osteoporotic Vertebral Compression Fracture Patients?[J]. Korean J Neurotrauma,2019, 15(1): 19-27.
- [2]Zhang J, He X, Fan Y, et al. Risk factors for conservative treatment failure in acute osteoporotic vertebral compression fractures (OVCFs)[J].Arch Osteoporos, 2019, 14(1): 24.
- [3]Chen YC, Zhang L, Li EN, et al. Unilateral versus bilateral percutaneous vertebroplasty for osteoporotic vertebral

- compression fractures in elderly patients: A meta-analysis[J]. *Medicine (Baltimore)*, 2019, 98(8): e14317.
- [4]Cheng J, Muheremu A, Zeng X, et al. Percutaneous vertebroplasty vs balloon kyphoplasty in the treatment of newly onset osteoporotic vertebral compression fractures: A retrospective cohort study[J]. *Medicine (Baltimore)*, 2019, 98(10): e14793.
- [5]Wang P, Li J, Song Z, et al. Utilization of the directional balloon technique to improve the effectiveness of percutaneous kyphoplasty in the treatment of osteoporotic vertebral compression fractures and reduction of bone cement leakage[J]. *Medicine (Baltimore)*, 2019, 98(19): e15272.
- [6]Huang ZF, Xiao SX, Liu K, et al. Effectiveness Analysis of Percutaneous Kyphoplasty Combined with Zoledronic Acid in Treatment of Primary Osteoporotic Vertebral Compression Fractures[J]. *Pain Physician*, 2019, 22(1): 63-68.
- [7]Zhu RS, Kan SL, Ning GZ, et al. Which is the best treatment of osteoporotic vertebral compression fractures: balloon kyphoplasty, percutaneous vertebroplasty, or non-surgical treatment? A Bayesian network meta-analysis[J]. *Osteoporos Int*, 2019, 30(2): 287-298.
- [8]Yin H, He X, Yi H, et al. Analysis of the Causes on Poor Clinical Efficacy of Kyphoplasty Performed in Unilateral Transpedicular Puncture for the Treatment of Senile Osteoporotic Vertebral Compression Fractures[J]. *Sci Rep*, 2019, 9(1): 1498.
- [9]Yu WB, Jiang XB, Liang D, et al. Risk factors and score for recollapse of the augmented vertebrae after percutaneous vertebroplasty in osteoporotic vertebral compression fractures[J]. *Osteoporos Int*, 2019, 30(2): 423-430.
- [10]Noriega DC, Rodríguez-Monsalve F, Ramajo R, et al. Long-term safety and clinical performance of kyphoplasty and SpineJack® procedures in the treatment of osteoporotic vertebral compression fractures: a pilot, monocentric, investigator-initiated study[J]. *Osteoporos Int*, 2019, 30(3): 637-645.
- [11]Wang W, Duan K, Ma M, et al. Can an unipedicular approach replace bipedicular percutaneous vertebroplasty for osteoporotic vertebral compression fracture?[J]. *J Back Musculoskelet Rehabil*, 2019, 32(2): 261-267.
- [12]Chongyan W, Zhang X, Li S, et al. Mechanism of formation of intravertebral clefts in osteoporotic vertebral compression fractures: An in vitro biomechanical study[J]. *Spine J*, 2018, 18(12): 2297-2301.
- [13]Zhang P, Zhong ZH, Yu HT, et al. Therapeutic effects of new-type hydraulic delivery vertebroplasty, balloon kyphoplasty and conventional pusher-type vertebroplasty on single segmental osteoporotic vertebral compression fracture[J]. *Exp Ther Med*, 2018, 16(4): 3553-3561.
- [14]Li Y, Wang X, Jiang K, et al. Incidence and risk factors of facet joint violation following percutaneous kyphoplasty for osteoporotic vertebral compression fractures[J]. *Acta Radiol*, 2019, 60(6): 755-761.
- [15]Lin J, Qian L, Jiang C, et al. Bone cement distribution is a potential predictor to the reconstructive effects of unilateral percutaneous kyphoplasty in OVCFs: a retrospective study[J]. *J Orthop Surg Res*, 2018, 13(1): 140.
- [16]Wang H, Hu P, Wu D, et al. Anatomical feasibility study of unilateral percutaneous kyphoplasty for lumbar through the conventional transpedicular approach: An observational study using 3D CT analysis[J]. *Medicine (Baltimore)*, 2018, 97(37): e12314.
- [17]Xiang GH, Tong MJ, Lou C, et al. The Role of Unilateral Balloon Kyphoplasty for the Treatment of Patients with OVCFs: A Systematic Review and Meta-Analysis[J]. *Pain Physician*, 2018, 21(3): 209-218.

- [18]Chen X, Guo W, Li Q, et al. Is Unilateral Percutaneous Kyphoplasty Superior to Bilateral Percutaneous Kyphoplasty for Osteoporotic Vertebral Compression Fractures? Evidence from a Systematic Review of Discordant Meta-Analyses[J]. Pain Physician, 2018, 21(4): 327-336.
- [19]Chen Q, Liu L, Liang G. Distribution characteristics of bone cement used for unilateral puncture percutaneous vertebroplasty in multiple planes[J]. Orthopade, 2018, 47(7): 585-589.
- [20]Yilmaz A, Çakir M, Yücetaş CŞ, et al. Percutaneous Kyphoplasty: Is Bilateral Approach Necessary?[J]. Spine (Phila Pa 1976), 2018, 43(14): 977-983.
- [21]Liu J, Liu Z, Luo J, et al. Influence of vertebral bone mineral density on total dispersion volume of bone cement in vertebroplasty[J]. Medicine (Baltimore), 2019, 98(12): e14941.