

Clinical curative effect of *Percutaneous vertebroplasty* combined with ^{125}I -seed implantation in treating spinal metastatic tumor

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Abstract: This paper selected and studied 15 in-hospital patients to analyze and discuss the clinical curative effect of percutaneous vertebroplasty (PVP) combined with ^{125}I -seed implantation in treating spinal metastatic tumor. The evaluation of clinical curative effects was based on the observation of several factors, namely recovery conditions of vertebral body's leading edge and middle section before and after surgery, improvements of kyphosis Cobb angle, visual analog scale (VAS), and Barthel Index (BI). The paper found significant difference between preoperative VAS and postoperative VAS, and the same situation occurred to BI. However, compared to the loss rate of vertebral body's leading edge and middle section and the improvement of Cobb angle before operative, postoperative loss rate and Cobb angle did not show statistical difference. Thus the conclusion is that PVP combined with ^{125}I -seed implantation is a minimally invasive surgery for effectively treating spinal metastatic tumor, which does well in rapidly releasing pains, improving patients' daily life activities and life qualities.

Keywords: PVP, ^{125}I -seed implantation; spinal metastatic tumor.

INTRODUCTOIN

Spine is the most common location for malignant neoplastic bone metastasis, and thoracic vertebrae witnesses most metastasis, followed by lumbar vertebra. Metastasized tumors damage vertebra and its appendixes to cause vertebral compression fracture, which finally leads to rachiterata and unstable spines. Besides, metastasized vertebra will have a violent feeling of pain, and even nerves are compressed to bring about worse results, influencing patients' life and mental conditions (Ming and Zhongliang, 2014). It has been reported that traditional surgery is not applicable in treating cancer patients with non adjacent vertebral metastasis (Qijian *et al.*, 2014). Chemotherapy and radiotherapy are palliative and conservative treatment methods that can kill pains and control tumor metastasis. However, because vertebral mechanical properties remain unchanged, those two methods with limited effects do not come off in the treatment of vertebral fracture and unstable spine. Thus, currently researches aim to control and slow down the development of tumor lesion while enhancing the mechanical properties of involved vertebra.

Percutaneous vertebroplasty (PVP) infuses vertebral lesions with Polymethymethacrylate (PMMA) through percutaneous puncture, which can enhance vertebra strength and spine stability to prevent collapse, relieve lumbago and back pains and rebuild local vertebral heights (Xiaoxi *et al.*, 2014; Qiyu *et al.*, 2014). In recent years, PVP has been gradually applied in treating tumors of metastatic spines, with excellent effects approved by clinicians and patients. Although PVP, as a local

treatment, is able to increase spinal stability to relieve or remove pains and prevent vertebral collapse, it plays a small role in tumor resistance. To effectively control the advancement of local tumor lesion, on the basis of PVP, many scholars have achieved certain clinical effects in the treatment of spine tumor by external radiotherapy or combined local chemotherapy with medicine carrying bone cement (Shan, 2010). While interstitial brachytherapy with ^{125}I -seed implantation destroys DNA duplex in tumor cell nucleus by γ -ray delivered by miniature radioactive source, in order to kill tumor cells and deprive tumor cells' reproduction capability to gain effective treatment (Wei *et al.*, 2014).

Inspired by combined technology, basic experiments were carried out to do researches on the comprehensive application of PVP and interstitial brachytherapy with ^{125}I -seed implantation among vertebral bone tissues. In the past two years, 15 cases of spine metastasized tumor with 21 vertebra were treated by PVP combined with ^{125}I -seed implantation in the hospital where the author worked. Below is the report of follow-up with satisfying curative effects.

MATERIALS AND METHODS

General information

A total of 15 patients (21 vertebrae) with spinal metastatic tumor were observed in this paper, among which 9 were males (13 vertebrae) and 6 were females (8 vertebrae). The age of patients varied from 45 to 82 years with the mean age of 62 years. When checked in, based on physical examination and imaging examination, patients were confirmed with spinal metastatic tumor whose major performance was back pain. Besides, some patients

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performed decreasing capability in daily life activities with different degrees; but all patients were not noticed with spinal cord and nerve compression. To be specific, the objectives contained three vertebra of T5, T11 and L3 (one vertebra for each); 2 cases of T6, T9 and L4; 3 cases of T7; 4 cases of T8 and 5 cases of T 10.

Research methods

Preoperative processing

Symptomatic treatment was adopted in patients' bed laying, pain killing and nutrition supplement before operation; and preoperative percutaneous puncture biopsy confirmed radiotherapy sensitivity with clear pathological diagnosis. Tests of X-ray, CT and MRI defined posterior wall completeness of vertebral body, detailed position and size of radix arcus vertebrae and specific range of tumor invasion, which excluded the possibility of traditional surgery.

Operation planning

Patients lay prostrate with local anaesthesia, and maintained electrocardiographic monitoring constantly. When local anaesthesia was finished, bedside C-type arm fluoroscopy was made to determine specific locations of vertebral lesions and radix arcus vertebrae, which was marked in body surface to make preparation for puncture. Then those marked places were percutaneously punctured with puncture trocar system provided by Kyphon Company in the United States, which aimed to make the puncture needle reach vertebra lesions along radix arcus vertebrae. Once the needle point reached vertebral tumor and damaged the tumor center, core needle was drawn out without sleeve. After that, it was time to infuse properly measured imaging agent whose distribution in vertebra and percolation out vertebra were observed. With the help of bedside C-type arm, 8~15 particles of ¹²⁵I-seed was implanted in to target areas of vertebra (vertebra metastases) through puncture sleeve; then with bedside C-type arm fluoroscopy, adjust the puncture needle point to the former 1/3 position of vertebra, and infuse prepared bone cement into vertebra until obstruction increased or bone cement permeated to the trailing edge of vertebra. Generally speaking, extract the puncture needle when bone cement reached 3~4 ml of thoracic vertebra or 5~6 ml of lumbar vertebra, finally dress the puncture.

Postoperative processing

Preventative antibiotics were used for 2~3 days after operation. During the second and fifth day after operation, the treatment of primary tumor was continued depending on patients' conditions, such as sitting up and off-bed activities.

Evaluating method

(1) Hu Hua et al. discussed and analyzed relative factors of great vertebra loss after percutaneous kyphoplasty (PKP) treating osteoporotic vertebral compression fracture. The great loss rate of vertebra in this paper was

determined according to the calculating method in Hu Hua's analysis (Hua *et al.*, 2014).

(2) VAS determination. Find a paper, and draw a 10 cm transverse line whose one end was 0 representing painless and another end 10 meaning sharp pain. Between 0 and 10, numbers meant pains with different degrees. Patients marked their pain degrees on the line with self-feelings, among which mean mild pain was (2.57±1.04), mean moderate pain was (5.18±1.41) and mean severe pain was (8.41±1.35).

(3) Cobb angle determination. In this paper, lower normal vertebral endplate and higher normal vertebral endplate which close to vertebra with metastasized tumor had two extension lines possessing two perpendicular lines, and Cobb angle was considered as the included angle of those perpendicular lines.

(4) BI measurement. Daily life movements were divided into 10 projects with 100 scores, including shower, feed, clothing, decoration, urination control, defecation control, washing room usage, 45 m walking, bed and chair movement, and stair activities. Mild functional deficit was marked as 75~95 scores, moderate functional deficit was 50~70, worse was 25~45 and worst 0~20.

Statistical method

All data were processed by SPSS19.0 statistics software, and normal measurement data were presented as $\bar{x} \pm s$. Independent sample t test was performed in inter-group comparisons; and the differences were regarded as statistically significant if $P < 0.05$.

RESULTS

Figure 1 below presented thoracic vertebra and paravertebral vascular system. All patients' general conditions were observed, including sitting up and off-bed activities, from the second day after operation until the fifth day. Radio-graphic examination after operation did not find bone cement spillovers and ¹²⁵I-seed flowing out vertebra. In addition, injury of spinal nerve root did not occur, so did infection and hematocucus; and pain was basically eased or completely removed.

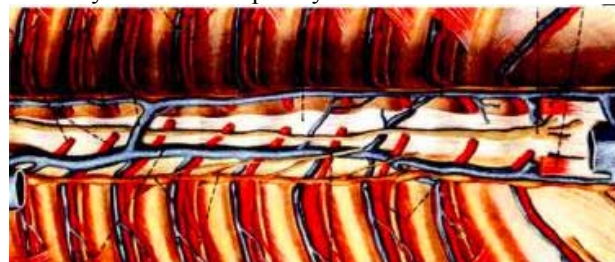


Fig. 1: Thoracic vertebra and paravertebral vascular system.

Table 1: Comparison of VAS and BI before and after operation (score)

Groups	Cases	VAS	BI
Pre-operation	21	6.37±1.67	39.53±6.98
Post-operation	21	1.32±0.75	78.23±3.89

Table 2: Comparison of Cobb angle, great loss rate of vertebral's leading edge and middle section before and after operation

Groups	Cases	Cobb angle	Great loss rate of vertebral's leading edge (%)	Great loss rate of vertebral's middle section (%)
Pre-operation	21	21.08±8.65	4.41±15.86	16.26±8.21
Post-operation	21	18.36±7.31	24.58±15.32	14.46±9.01

Postoperative VAS and BI were compared to those ones before operation, which was shown in table 1.

It could be noticed from table 1 that compared to pre-operation, post-operative VAS greatly decreased and the difference was statistically significant with $P < 0.01$, so did BI.

Table 2 presented Cobb angles, great loss rates of vertebral body's leading edge and middle section before and after operation and their comparisons.

From table 2, it was obvious that the difference between preoperative and postoperative Cobb was not significant in statistics; and the same situation occurred to great loss rates of vertebrae's leading edge and middle section.

DISCUSSION

Malignant tumor bone metastasis commonly occurs in thoracic vertebra and lumbar vertebra of spine, and spinal metastasis happens to 70% of patients with metastasized cancer. Once spinal metastasis happens, spinal stability decreases because of vertebra damages and mechanical pains occur because of micro-fracture; besides, tumor invasion and expansive growth cause pains via surrounding nerve endings. PVP infuses curing agents, like bone cement, to vertebral lesions to immediately fix and enhance vertebra. To be explained in details, PMMA with its cytotoxicity makes tumor cells dehydrate, coagulate and even die; if micro-fracture is fixed, nerve endings of pain will not be activated by vertical extrusion and traversal friction. Besides, bone cement cuts off blood supplement for tumors to kill tumor tissues through its mechanical function of adhesion and hardening; while bone cement in polymerization reaction releases heat under 72~78 °C which is effective enough in destroying tumor tissues and pain nerve endings of vertebra. Furthermore, hard bone cement increase the support of vertebra to maintain vertebra functions (Yulin, 2014). To control tumor metastasis, scholars adopted PVP combined with in vitro radiotherapy or combined local chemo-

therapy with medicine carrying bone cement to treat spinal metastatic tumor, expecting to push forward treating effects (Tao *et al.*, 2014; Xiaofeng *et al.*, 2014). Based on this, Xie Xiaoxi et al. applied PVP combined with ^{125}I -seed implanted interstitial brachytherapy in vertebra bone tissues to treat spinal tumor, which resulted in unique technological advantages and satisfying effects in clinic (Xiaoxi *et al.*, 2012).

Speaking of curing spinal metastatic tumor, PVP possesses its advantages compared to surgery. On one hand, simple and low-priced as PVP, it enhances mechanical strength of vertebra and improves local soft tissues by stagnating and killing tumor lesions. On the other hand, PVP, as a minimally invasive surgical technology, is more easily accepted by patients with its remarkable clinical curative effect. ^{125}I -seed, an artificially synthesized isotope, has accurate location with low energy and constancy, which helps destroy tumor cells. Besides, the half-life period of ^{125}I -seed lasts for a long time; when ^{125}I -seed decayed, it releases γ -ray to kill tumor cells whose DNA synthesis phase is greatly influenced, aiming to achieve successful treatment (Junlin and Xiaoli, 2013; Song *et al.*, 2014).

PVP combined with ^{125}I -seed implantation in treating spinal metastatic tumor is a composite treatment, which cures tumors in a physical and biological way. By such a method, vertebra mechanism is strengthened and tumor cells are killed. As a minimally invasive technology, this method rapidly relieves pains, improves patients' daily life capabilities and enables patients to require better lives, which is proved in this research with notably statistical difference of VAS and BI before and after operation. For patients with primary tumor and spinal metastatic tumor lesion confirmed by iconography, this method is proper and perfect. However, research conducted by Ren Chao et al. found that kyphosis of diseased vertebra is unable to be rectified by this method, which is also presented in this paper (Chao *et al.*, 2013). In addition, tumor can not be totally cured because tumor itself is not removed.

This method must be operated strictly according to working regulations of radioactive ray, which involves self-protection. Meanwhile, family members of patients should be publicized with protective knowledge of ¹²⁵I-seed, and informed to keep 1 m away from patients. Especially for children and pregnant women, close visiting of patients is not advocated. After operation, it is necessary to regularly check seed resource metastasis to guarantee patients' life security.

CONCLUSION

According to the researches in this paper, PVP is highlighted by micro-trauma, simple operation and less complication, which is effective in treating patients' pains resulting from spinal metastatic tumor. PVP combined with ¹²⁵I-seed implantation is an effective minimally invasive surgery for treating spinal metastatic tumor, functioning well in rapidly releasing pains, improving patients' daily life activities and life qualities.

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