Bone and Arthrosurgery Science, 2024, Volume 2, Issue 4
http://ojs.bbwpublisher.com/index.php/BAS
Online ISSN: 2981-8222

Clinical Observation of Zero-P System Interbody Fusion Combined with Traditional Chinese Medicine-Directed Drug Delivery Technology for Treating Cervical Spondylotic Myelopathy

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Abstract: *Objective:* To investigate the clinical efficacy of the Zero-profile fusion cage (Zero-P) combined with Traditional Chinese Medicine-directed drug delivery technique in the treatment of cervical spondylotic myelopathy, and to assess its impact on potential postoperative complications. *Methods:* 13 patients with cervical spondylotic myelopathy were selected from January 2022 to October 2023. The intraoperative bleeding volume, operation duration, and hospitalization days were recorded, the incidence and improvement of postoperative complications were observed, and the pain index and cervical function index were analyzed, including Visual Analogue Scale (VAS) score, Japanese Orthopedic Association (JOA) score, Neck Disability Index (NDI) index, etc. *Results:* The operation duration of patients was 65–110 (81.92 ± 13.47) min; mean intraoperative blood loss was 12.30 ± 7.80 ml, and mean postoperative hospital days were 9.62 ± 3.52 days. All patients in this group were followed up over 3 months after surgery, and the study found that the VAS, JOA, and NDI scores improved significantly compared with the preoperative difference ($P < 0.01$); and the VAS, JOA, and NDI scores 1 month postoperative improved significantly compared with 1 week postoperative ($P < 0.01$). In addition, the incidence of postoperative complications of the Zero-P system was low, with no incision infection, implant rejection, fracture, displacement, cerebrospinal fluid leakage, recurrent laryngeal nerve injury, and laryngeal edema; one patient had mild dysphagia (7.69%) and nine patients had throat dryness and discomfort (69.23%), which completely disappeared after 1 week of TCM-directed drug treatment and symptomatic treatment. *Conclusion:* Zero-P system interbody fusion has a significant effect on cervical spondylotic myelopathy, with a low incidence of postoperative complications and fast improvement speed, which can effectively enhance the impact of surgery on cervical spondylotic myelopathy patients, thus it is worthy of application and promotion.

Keywords: Cervical spondylotic myelopathy; Anterior cervical discectomy and fusion; Zero-P system; Zero-profile; TCM-directed drug delivery technology

Online publication: September 9, 2024

1. Introduction

Cervical spondylotic myelopathy (CSM) is a type of degenerative cervical spine disorder. It is one of the more severe forms of cervical spondylosis in terms of symptoms and impact. This condition is often caused by factors such as degenerative changes in the cervical intervertebral discs, disc protrusion, hypertrophy of the vertebral body, and ossification of the posterior longitudinal ligament, which can compress or cause ischemia of the spinal cord. As a result, patients experience a gradual decline in neurological function and quality of life [1,2]. For the treatment of CSM, non-surgical treatment can realize the improvement of neurological function to a certain extent, but with the deterioration of neurological function, the surgical approach is the most effective method for addressing localized kyphotic cervical spondylotic myelopathy, achieving the goals of spinal cord decompression, correction of localized kyphosis, and improvement of spinal stability [3]. Currently, there are various options for surgical treatment of the cervical spine, and anterior cervical surgery remains the gold standard for the treatment of CSM involving fewer than three segments [1], including traditional anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF), and so on. For the choice of internal fixation materials, titanium plates, Zero-P system, and Peek-Prevail system are the most chosen [4]. Among them, titanium plate is the most widely used internal fixation material, but due to its irritation of the soft tissues at the anterior margin of the vertebral body and the esophagus, patients are prone to swallowing difficulties and other related defects. The application of the Zero-P system has the advantage of slowing down the degeneration of the adjacent vertebral body and reducing the irritation of the esophagus [5]. In addition, according to the clinical manifestations of CSM, which is in line with the categories of "paralysis," "impotence," and "vertigo" in traditional Chinese medicine, acupuncture, moxibustion, hot packs of Chinese medicine, fumigation, and ointment application are commonly used external treatments in traditional Chinese medicine (TCM) that have demonstrated significant effectiveness in treating this condition. This paper retrospectively analyzed the data of patients with CSM treated with Zero-P system interbody fusion combined with TCM-directed drug delivery technology in the Orthopedic Trauma Department of Lanzhou Petrochemical General Hospital from January 2022 to October 2023.

2. Clinical data and methods

2.1. Clinical data

13 patients with CSM treated with Zero-P system interbody fusion combined with TCM-directed drug delivery technology admitted to the Orthopedic Trauma Department of Lanzhou Petrochemical General Hospital from January 2022 to October 2023 were selected, with 4 males and 9 females, aged 45–75 years old, and the average age was 62.15 ± 7.43 years old. Implanted segments: single segment in 5 cases (C3–C4 in 1 case, C4–C5 in 0 cases, C5–C6 in 4 cases); double segments in 6 cases (C3–C5 in 2 cases, C4–C6 in 2 cases, C5–C7 in 2 cases); triple segments in 2 cases (C3–C6 in 2 cases).

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) Those who clearly met the diagnostic criteria of CSM and conformed to the Expert Consensus on Integrative Diagnosis and Treatment of Spinal Cervical Spondylosis with Traditional Chinese and Western Medicine [6]; (2) Those who had a long course of the disease, and who had not been treated effectively with systematic and standardized conservative treatments for more than 3 months; (3) Those who had clear lesions of the three segments and the following intervertebral space on the imaging; and (4) Those who had been approved by the Ethics Committee of the hospital and consented, were aware and agreed with the research project, can cooperate with the follow-up and are willing to sign the informed consent.

Exclusion criteria: (1) Cervical spinal cord compression from the posterior aspect of the spinal canal requiring posterior surgery; (2) Combined with infections in adjacent areas or systemic infections; (3) Combined with cervical vertebral fracture or dislocation; (4) Combined with severe cardiac, hepatic, and renal dysfunction and unable to tolerate surgery; (5) Poor adherence to the study and unable to cooperate with the follow-up.

2.3. Methods

2.3.1. Surgical methods

After the onset of general anesthesia, the patient took the supine position, the routine operation area was sterilized with iodine vapor, a sterile towel sheet was laid, and the operation area was covered with a protective film. An anterior transverse cervical incision was made in the diseased segment, and from the external anterior edge of the sternocleidomastoid muscle to the midline, the skin, subcutaneous and broad fascia were incised, and the carotid artery sheath and the anterior edge of the sternocleidomastoid muscle were retracted to the outside. The deep fascia was separated to the prevertebral fascia, and the anterior longitudinal ligament and the longissimus dorsi muscle were exposed. The medial portion of the longissimus dorsi muscle was separated by bipolar electrocoagulation electrocautery on both sides, and the muscle was pulled away to both sides respectively. The curved hook of the Cloward automatic anterior opener with teeth was placed underneath the separating edge of the longissimus cervicis muscle and opened to both sides to reveal the intervertebral disc. The intervertebral space was punctured with a localizing needle, and the diseased segment was confirmed by X-ray fluoroscopy. A second toothless retractor was used to open the intervertebral disc upward and downward to reveal the upper and lower ends of the intervertebral disc up to the upper and lower vertebral bodies. The anterior longitudinal ligament and the annulus fibrosus were incised and the intervertebral disc was resected with a curved or straight short curette and vertical forceps up to the posterior margin of the intervertebral disc. The intervertebral space was opened up with a Cloward space widener, and the chondral plate and subchondral vertebral body bone of about 1 mm and the increased bone at the posterior margin of the vertebral body were removed with a curette to enlarge the intervertebral space up to 6 mm. After removal, the anterior cervical interbody fusion device was filled with allograft bone, the interbody fusion device was inserted and screws were screwed into the fusion device after the cancellous bone was filled solidly. After C-arm fluoroscopy, the interbody fusion device was seen to be in a good position. Decompression with interbody fusion was performed in the same way for the rest of the diseased vertebrae. After flushing the incision, the wound was free of bleeding and oozing, and a drain was placed. After counting the instruments and dressings, the wound was sutured layer by layer, and the operative area was fixed with dressing and cervical support.

2.3.2. Postoperative treatment

Postoperative routine application of cefuroxime 1.5 g + 100 ml saline (intravenous drip, 2 times/day, for 2 days) to prevent infection, methylprednisolone 80 mg + 250 ml saline (intravenous drip, 1 time/day, adjust the dosage of 40 mg after 3 days, continue the intravenous drip for 3 days), mannitol 125 ml (intravenous drip, 2 times/day), combined with rehydration, analgesia, neurological nutrient, and other symptomatic treatment. Drainage flow was closely monitored, and drainage flow < 50 ml was removed within 24 hours after operation. All patients had their necks immobilized with a brace for three months after surgery. In the absence of any special discomfort, they were allowed to engage in protective functional exercises on the ground.

After 6 hours of the postoperative period, the patients were treated with TCM-directed drug delivery therapy. The therapeutic instrument used was the Kangwo Traditional Chinese Medicine Directed Drug Penetration Therapy Instrument (Model: KW-1LTYJ, Registration No.: SuXieZhuZhun 20202091003)

manufactured by Taizhou Kangwo Medical Equipment Co., Ltd. The electrode pads coated with medication were placed on the most prominent pain areas of the patient's neck and shoulders (avoiding the surgical site). The temperature was adjusted based on the patient's tolerance, with each treatment session lasting 20–25 minutes, once daily, for a duration of one week. The medication composition was: 15 g of Gui Zhi (cinnamon twig), 15 g of Du Huo (*Angelica pubescens*), 15 g of Dang Gui (*Angelica sinensis*), 12 g of Bai Shao (White Peony Root), 12 g of Du Zhong (*Eucommia* bark, toasted), 15 g of Sang Ji Sheng (mulberry mistletoe), 10 g of Qin Jiao (*Gentiana macrophylla*), and 15 g of Fang Feng (siler root). The herbs were decocted, and the residue was discarded.

2.4. Observation indicators

(1) Perioperative indicators: The intraoperative bleeding, duration of surgery, and postoperative hospitalization days were recorded.

(2) Postoperative complications: The incidences of incision infection, implant rejection, fracture, displacement, cerebrospinal fluid leakage, recurrent laryngeal nerve and vagus nerve injury, laryngeal edema, hoarseness, and dysphagia in all patients on the first day, one week after surgery, and three months after surgery were recorded, of which the evaluation of dysphagia was assessed using the Bazaz grading system evaluation.

(3) Pain and function indexes: The Visual Analogue Scale (VAS) score, Japanese Orthopedic Association (JOA) score, and Neck Disability Index (NDI) index of all patients were recorded and analyzed before surgery, one day after surgery, one week after surgery, and three months after surgery; and the pain and cervical spine function improvement of patients were evaluated before and after surgery.

2.5. Statistical methods

All data were statistically analyzed using SPSS25.0 statistical analysis software, and count data were expressed as [n (%)]. Measurement data that conformed to normal distribution were expressed as mean ± standard deviation (SD), and the data at each time point were analyzed by one-way ANOVA, and two-by-two comparisons were made by LSD-t test or SNK-q test; measurement data that did not conform to normal distribution were expressed as Mean (P25%, P75%), and compared by rank-sum test. Test standard: $\alpha = 0.05$.

3. Results

All patients successfully completed the operation, the operation duration was 65–110 min, the average operation duration was 81.92 ± 13.47 min, the average intraoperative bleeding was 12.30 ± 7.80 ml, and the average postoperative hospitalization days were 9.62 ± 3.52 days. All patients did not suffer from incisional infections, implant rejection, fracture, displacement, cerebrospinal fluid leakage, laryngeal nerve injury, laryngeal edema, and other complications. There was one patient with mild dysphagia (evaluated using the Bazaz grading system), with an incidence rate of 7.69%, and nine patients with dryness and discomfort in the throat, with an incidence rate of 69.23%, and the above symptoms completely disappeared in the patients after one week of treatment by TCM-directed drug delivery technology. Comparing the efficacy indexes of all patients before and after surgery, it can be seen that the VAS, JOA, and NDI scores three months after surgery were significantly improved compared with the preoperative period, and the difference was significant ($P < 0.01$). The VAS, JOA, and NDI scores of all patients one month after surgery improved significantly compared with one week after surgery ($l < 0.01$), as shown in **Table 1**. **Figures 1** and **2** show two CSM cases in this study.

Table 1. Comparison of pain and functional indexes before and after surgery mean ± SD, $n = 13$)

Observation time	VAS score	JOA score	NDI index
Preoperative	7.38 ± 0.96	7.54 ± 0.88	23.62 ± 1.76
1 week after surgery	2.92 ± 0.76*	8.92 ± 0.95*	18.92 ± 1.61*
1 month after surgery	1.54 ± 0.66*#	11.92 ± 0.86*#	13.92 ± 1.26*#
3 months after surgery	1.08 ± 0.49*# △	13.92 ± 1.12*#○	9.08 ± 1.66*#○
F value	197.647	118.070	205.125
P value	< 0.001	< 0.001	< 0.001

Note: * indicates $P < 0.01$ compared with preoperative, # indicates $P < 0.01$ compared with 1 week postoperative, △ indicates $P > 0.01$ compared with 1 month postoperative, and ○ indicates $P < 0.01$ compared with 1 month postoperative.

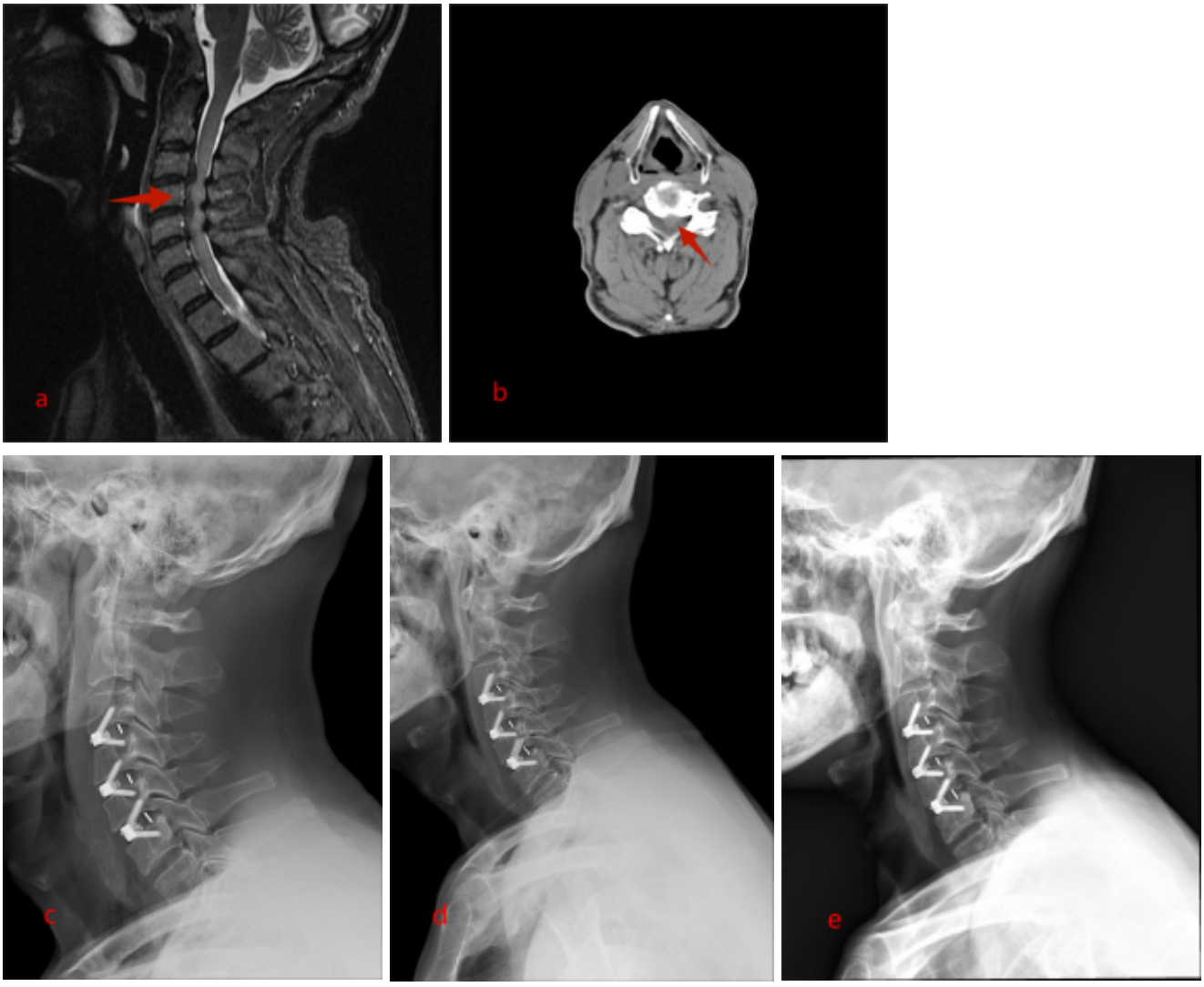

Figure 1. The patient, male, was admitted with "neck and shoulder pain for 1 year, worsening for 1 month." The patient underwent a three-segment Zero-P anterior cervical decompression and fusion with internal fixation. (a) Preoperative MRI showed intervertebral disc herniation at C3/4, C4/5, and C5/6, with spinal canal stenosis and compression-induced degeneration of the spinal cord. (b) Preoperative CT revealed significant intervertebral disc herniation within the spinal canal. (c) One-week postoperative cervical spine digital radiography (DR) using the Zero-P system. (d) One-month postoperative follow-up cervical spine DR. (e) Three-month postoperative follow-up cervical spine DR indicated that the internal fixation was in good condition with no displacement or loosening, and improvement in cervical curvature.

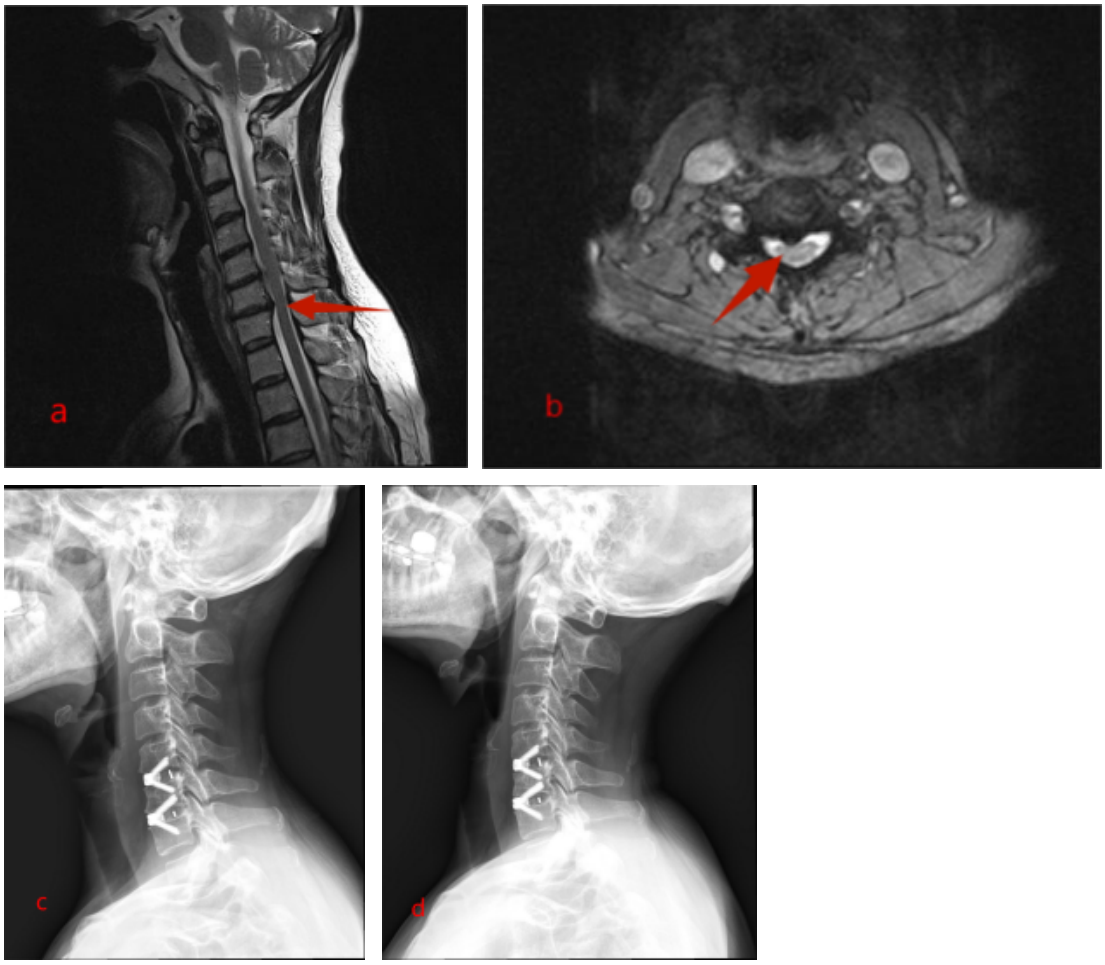

Figure 2. The patient, male, was admitted with "intermittent neck and shoulder pain for over 5 years, worsening in the past week." Following admission, he underwent a two-segment Zero-P anterior cervical decompression and fusion with internal fixation. (a) Preoperative MRI showed straightening of the cervical physiological curvature, disc herniation at C5/6 and C6/7, and disc space narrowing. (b) Preoperative MRI indicated disc herniation extending into the spinal canal. (c) One week post-surgery cervical spine DR showed stable placement of the internal fixation in the affected disc spaces. (d) Three months post-surgery cervical spine DR indicated good restoration of cervical curvature, increased disc height, and proper positioning of the internal fixation.

4. Discussion

Degenerative changes in the cervical spine are the primary factors contributing to cervical spondylotic myelopathy. These changes occur due to alterations in the proteoglycan components of the intervertebral disc nucleus, which affect the nucleus's mobility and the degree of fibrosis. Under the conditions of altered cervical spine biomechanics, degenerative changes ensue, including disc bulging/herniation, thickening and calcification of the posterior longitudinal ligament, and osteophyte formation in the vertebral body. In addition, excessive flexion and extension of cervical spine activities tend to cause overlapping of the vertebral plates and folding of the ligamentum flavum, which in turn cause cervical spinal stenosis, further resulting in mechanical compression of the spinal cord in the vertebral canal and sustained ischemic response [7,8]. Therefore, surgical treatment for cervical spondylotic myelopathy is aimed at relieving spinal stenosis and improving spinal cord compression and ischemia. Currently, ACDF surgery is the main treatment option for CSM patients with lesions ≤ 3 segments and compression from the anterior aspect of the spinal cord [6]. The combination of ACDF and traditional titanium interbody fusion can rapidly relieve spinal cord compression and reduce neurological symptoms, and it has the advantages of immediate stability, high fusion rate, and low incidence of

pseudoarthrosis. However, due to its material and structural characteristics, the incidence of complications such as postoperative swallowing difficulties, titanium plate displacement and fracture, screw loosening, adjacent vertebral body ossification, and esophageal perforation is relatively high [9,10]. Some studies have shown that the likelihood of dysphagia with titanium plates is 4–57% in the first three months of postoperative life, and the incidence of dysphagia lasting more than three months is 12–39% [11].

The Zero-P system was developed with this in mind. Also known as the Zero-profile self-locking fusion cage, its structure features a titanium-coated surface on a base of polyether ether ketone (PEEK) material, with screw channels positioned at the front of the fusion cage, unlike the anterior screw placement of traditional titanium plates. This unique structural design allows the screws to be angled and diverged into the end plates of adjacent vertebrae during fixation, significantly enhancing the pull-out resistance of the fusion cage and improving its stability. Additionally, this design minimizes stimulation to the anterior vertebral body and esophagus, thereby reducing the incidence of complications such as dysphagia [12,13]. Based on this study, it was observed that the number of cases with mild dysphagia after surgery was one case, and there were no cases with moderate and severe dysphagia, and the duration of surgery and intraoperative bleeding were less than those of general ACDF surgery. In addition, this study found that the intraoperative bleeding in fusion internal fixation with a Zero-P system ranged from 5 ml to 30 ml, with an average of 12.30 ± 7.80 ml, this was much lower than that in fusion with a titanium plate, which was closely related to the specific structure of Zero-P system. Meanwhile, the Zero-P system had a significant effect on the improvement of Cobb angle, intervertebral space height, and adjacent vertebral ossification rate after cervical spine surgery. Cao *et al.* [14] performed a clinical control analysis of 116 patients with cervical degenerative disease who underwent Zero-P self-locking fusion versus conventional titanium plate fusion, and found that the two fusion systems improved the physiological curvature of the cervical spine and the height of the intervertebral space, with a highly significant difference ($P = 0.000$), and the physiological curvature and the height of the intervertebral space in the Zero-P group was better than that of the conventional titanium plate group, with a highly significant difference ($P = 0.000$). Yun *et al.* [15] analyzed 63 patients with two-stage spinal cervical spondylosis and found that the improvement of preoperative and postoperative Cobb angle was clinically significant in both groups, and there was a significant difference in Cobb S of the Zero-P group compared with that of the titanium plate group in the third month after the operation ($P = 0.000$), and there was no difference in Cobb C, although there was an improvement ($P = 0.244$). Due to the short follow-up period of this study, there was no specific supporting evidence for the improvement of the Cobb angle.

However, the Zero-P system has a lower incidence than the titanium plate interbody fusion system for some perioperative indexes (including intraoperative bleeding and operation length), postoperative cervical Cobb angle and interbody height, and postoperative complications (especially dysphagia) in patients with cervical spondylosis, but there is still a possibility for postoperative complications (including dysphagia), which is impossible to completely prevent. For some patients with refractory cervical spondylosis who have long-term symptoms and heavy spinal cord compression and degeneration, after ACDF combined with Zero-P fusion and internal fixation, they can still be accompanied by varying degrees of neurogenic symptoms, which in turn affects the quality of life of the patients. Wang *et al.* [16] implanted the Zero-P system decompression and fusion in 27 patients with uni-segmental spinal cord cervical spondylosis, and there was one patient with dysphagia three days after the operation. Guo *et al.* [17] evaluated the efficacy of the Zero-P system in 23 patients with cervical spondylotic myelopathy with a sustained 3-segment lesion site and found that eight patients presented with mild postoperative dysphagia.

Therefore, the selection of appropriate adjuvant therapies is particularly necessary for consolidation therapy

after Zero-P system implantation. Some studies have shown that mechanical compression, biochemical factor stimulation, and blood circulation are all major causes of cervical spondylosis [18]. Chinese medicine-directed drug delivery technology is currently commonly used in clinical orthopedics auxiliary treatment means. It is a traditional Chinese medicine external treatment technology and ion introduction technology combined with a class of auxiliary therapies, through a single pulse electric field that temporarily opens the skin stratum corneum channel, effectively promoting the penetration of traditional Chinese medicine ions into the body and directing to the target site, exerting anti-inflammatory and analgesic effects, promoting regeneration of tissues and excitation of the neuromuscular, improving the efficacy of local circulation, etc. [19], thus effectively promoting the improvement of the disease [20]. This study selected formula for transdermal medication comprising eight herbs: Gui Zhi (cinnamon twig), Du Huo (*Angelica pubescens*), Dang Gui (*Angelica sinensis*), Bai Shao (white peony root), Du Zhong (*Eucommia* bark), Sang Ji Sheng (mulberry mistletoe), Qin Jiao (*Gentiana macrophylla*), and Fang Feng (siler root). This combination is intended to promote meridian circulation, relieve pain, and replenish qi and blood. In the formula, Du Huo and Sang Ji Sheng are used as the chief ingredients. Du Huo is known for its effectiveness in dispelling wind and dampness, and alleviating pain, and Sang Ji Sheng is used to tonify the liver and kidneys and strengthen the bones. Together, they address the liver and kidney deficiency type of cervical spondylosis by tonifying the liver and kidneys, expelling wind, and dispelling dampness. Modern pharmacological studies have shown that Du Huo and Sang Ji Sheng are rich in quercetin and β-sitosterol, which can effectively inhibit the release of pro-inflammatory factors and reduce the expression of inflammatory factors such as TNF-α, IL-1β, IL-6, and have strong anti-inflammatory and antioxidant effects [21]. Qin Jiao (*Gentiana macrophylla*) and Fang Feng (siler root) are known for their balanced and non-drying properties, earning them the designation of "moisturizers among wind-dispelling agents." These herbs are representative of wind-dispelling medicines and, when used together, have the effects of dispelling wind, relieving the exterior, and eliminating dampness while alleviating pain. Pharmacological studies have shown that both herbs contain active substances such as alkaloids, flavonoids, and polysaccharides. These compounds exhibit significant anti-inflammatory, antioxidant, and immune-regulating effects [22]. The combination of Bai Shao (white peony root) and Gui Zhi (cinnamon twig) is first documented in the classic formula Gui Zhi Tang from the *Shanghan Lun*. This pairing represents a classic example of a mutual restriction formula. Gui Zhi, with its warming and dispersing properties, helps to regulate the meridians and assist yang in transforming qi. In contrast, Bai Shao has astringent properties that nourish the blood, soothe the liver, and alleviate pain. Together, these herbs balance and harmonize the body by combining warming and dispersing actions with nourishing and soothing effects. Pharmacological studies reveal that Gui Zhi contains cinnamaldehyde, which dilates blood vessels and improves peripheral circulation. Bai Shao contains paeoniflorin, which can regulate the immune system, reduce inflammation and pain, and improve blood rheology [23]. Bai Shao (white peony root) and Dang Gui (*Angelica* root) form a classic blood-moving herbal pair first described in the *Jingui Yaolüe* (*Essential Prescriptions from the Golden Cabinet*). Dang Gui is known for its ability to tonify and invigorate the blood, while Bai Shao is used to nourish the blood and astringe the yin. Together, these herbs combine dynamic and static actions, harmonizing dispersal and astringency, supporting blood without causing stagnation, and providing nourishment without inducing heat. Pharmacological research has shown that both herbs contain multiple active components. Notably, Dang Gui polysaccharides and paeoniflorin-1 have been found to regulate vascular morphogenesis, promote angiogenesis, and affect blood flow velocity [24]. Du Zhong (*Eucommia* bark) is a tonic herb known for its ability to tonify the liver and kidneys and strengthen bones and muscles. When combined with Dang Gui (*Angelica* root), it not only supplements kidney function and strengthens bones but also enhances blood nourishment and activation. Pharmacological studies indicate that Du Zhong contains

active compounds that exhibit anti-inflammatory and immune-regulating effects. Additionally, it affects the proliferation and differentiation of osteoclasts, osteoblasts, and bone marrow mesenchymal stem cells, influencing the absorption and formation of bone matrix. This results in the inhibition of bone destruction and the promotion of bone protection [25,26].

All the cases in this study were routinely applied with TCM-directed drug delivery technology after surgery, and it can be seen that the efficacy indexes of all patients before and after surgery appeared to have different degrees of improvement, and the VAS, JOA, and NDI scores of all patients after surgery were significantly improved compared with those before surgery ($P < 0.01$); and the VAS, JOA, and NDI scores of all patients in the first month after surgery improved significantly compared with those in the first week after surgery ($P < 0.01$). As for the improvement of postoperative complications, it can be seen that the symptoms of one patient (incidence rate of 7.69%) who experienced mild dysphagia and nine patients (incidence rate of 69.23%) who experienced dryness and discomfort in the throat completely disappeared within one week after the application of TCM-directed drug delivery medication.

5. Conclusion

In conclusion, Zero-P system interbody fusion has clear clinical efficacy for patients with cervical spondylotic myelopathy, which can effectively improve patients' pain, promote their functional recovery, and improve their quality of life. With the combination of Chinese medicine-directed drug delivery technology, it can also promote the early improvement of postoperative complications, especially dysphagia, and at the same time, it can also play an auxiliary therapeutic role in the postoperative recovery of patients with refractory cervical spondylosis. However, the follow-up period of this study was short, and the 3-month follow-up could not effectively study the cervical Cobb angle, intervertebral space, and other indexes, for which further long-term follow-up is especially necessary.

Disclosure statement

The authors declare no conflict of interest.

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