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Original Article

Effects of percutaneous endoscopic debridement, lavage and drainage intervention on postoperative infection and recovery of patients with pyogenic spondylitis

Weijie Tang[1], Liping Meng[2], Jingqi Han[3], Xiling Yin[4], Zuoji Feng[1]

Departments of [1]Orthopaedics, [2]Spleen and Stomach Diseases, [3]Imaging, [4]Nursing, Huangdao District Chinese Medicine Hospital, Qingdao 266500, Shandong, China

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Abstract: Objective: To observe the effect of percutaneous endoscopic debridement (PED), lavage and drainage in patients with pyogenic spondylitis (PS). Methods: One hundred and fifty-six patients with PS treated in Huangdao district Chinese Medicine Hospital from October 2017 to May 2019 were enrolled and allocated into two groups according to different treatment methods. There were 87 cases in the research group (RG) who received PED, lavage and drainage, and 69 cases in the control group (CG) who underwent traditional open anterior surgery. The surgical and biochemical indexes of the two groups were observed. Visual analogue scale (VAS) and Oswestry dysfunction index score were employed for pain degree and lumbar function evaluation at different time periods before and after operation. The preoperative and postoperative neurological functions of the two groups were determined by the American Spinal Injury Association (ASIA). Postoperative complications were observed and recorded, and the Short-Form 36 Item Health Survey (SF-36) scale was used for quality of life (QOL) evaluation of patients before and after operation. Results: The surgical indexes in the RG were statistically lower than those in the CG. CRP, ESR and WBC levels were remarkably reduced in the RG. VAS and Oswestry scores at 1 month and 3 months postoperatively were observed to be notably lower in the RG than in the CG. In comparison with the CG, the number of grades of C and D patients in the RG was evidently lower, while the number of Grade E patients was statistically higher. The total incidence of complications in the RG was dramatically lower, and the scores of postoperative QOL were noticeably higher as compared to the CG. Conclusions: Percutaneous endoscopic debridement, lavage and drainage for patients with PS can reduce infection, facilitate the recovery of lumbar function and neurological function of patients, and meliorate their postoperative QOL.

Keywords: Percutaneous endoscopic debridement, lavage and drainage, pyogenic spondylitis, postoperative infection, recovery status

Introduction

Pyogenic spondylitis (PS) is caused by infection in patient's intervertebral disc and soft tissue around the vertebral body, as well as the subchondral bone. The abscess invades from the subchondral lesion to the intervertebral disc, and the infection expands to the patient's epidural and paravertebral space [1, 2]. Moreover, because the arteries of the same segment supply both the lower part of the upper vertebra and the upper part of the lower cone, PS usually involves two adjacent cones [3]. Clinically, patients with initial stages of PS are mostly treated with conservative therapy, such as antibiotic treatment and fixation of the affected spinal segment, but as most patients are nonresponive to conservative treatment [4, 5], the development of active and effective treatment for PS is paramount.

With the continuous improvement in the understanding of spinal infectious diseases in recent years, the treatment methods such as radical debridement, sustaining bone grafting and rigid internal fixation have been widely recognized [6, 7]. However, conventional open spine surgery has great trauma, a high incidence of post-

operative complications and relatively high requirements on patients' general condition; moreover, most patients have limited options for open spinal surgery due to unfavorable cardiopulmonary function, adverse nutritional status and economic difficulties [8, 9]. Therefore, percutaneous endoscopic debridement (PED), lavage and drainage were used in this study to treat PS. This new interventional endoscope approach uses a percutaneous puncture channel, which was previously placed by interventional radiology, directly targeting at the abscess or necrosis, and uses a flexible endoscope for debridement and flushing, allowing patients to avoid major surgery [10]. Dhingra R et al. [11] showed a high success rate of PED, lavage and drainage for patients with infectious pancreatic necrosis. In their research, 14 of the 15 patients improved significantly, and only 2 had complications after treatment. It is also shown that PED and lavage in the treatment of patients with lumbar PS can improve the bacterial diagnosis rate, relieve the patients' low back pain, and contribute to the elimination of lumbar PS, which is an effective alternative treatment for open surgery [12].

In this study, PED, lavage and drainage intervention were performed in patients with PS to explore the effects on postoperative infection, recovery and quality of life (QOL) in patients, aiming to provide a feasible treatment plan for patients with this disease.

Materials and methods

General information

From October 2017 to May 2019, 156 patients with PS treated in our hospital were enrolled and allocated into two groups based on the different treatment methods they received. There were 87 cases in the research group (RG), and they were treated with PED, lavage and drainage; and 69 patients in the control group (CG) were treated with traditional open anterior surgery. Inclusion criteria: Patients in both groups were diagnosed with PS [13] with the clinical manifestations of intractable back pain, requiring anesthesia for pain relief and bed rest, and the general clinical data were complete. The Ethics Committee at the Huangdao District Chinese Medicine Hospital approved the experimental protocol, and all the enrolled patients and their families were informed of the details and provided written informed consent. Exclusion criteria: Patients who had already received spinal surgery, those who withdrew from the study, or did not cooperate with the researchers or were lost to follow up, or those with multi-level infections, cauda equina syndrome, a family history of neurological deficits and/or mental illness or coagulation disorders, were excluded.

Surgical procedures

CG: Anterior open surgery was performed using retroperitoneal approaches, and all infected and necrotic tissues, as well as intervertebral disc materials with endplates were completely removed until healthy bleeding bone were obtained. The scope of debridement was up to infection degree, which was assessed according to preoperative Magnetic Resonance Imaging (MRI) and intraoperative findings. After thorough debridement, the length of the intervertebral disc space was considered by measuring the autologous tricortical iliac pillar bone graft, and then it was firmly placed in place without internal fixation. In order to achieve a firm fusion, the graft was placed on the living bone, above and below. Subsequently, the drainage tube was not removed until the drainage stopped or fell below 50 ml/day for three days in a row.

RG: The patients were given local anesthesia and supine position was adopted for surgery. On the basis of preoperative MRI and CT examination, the vertebral space of the lesion was determined, and the surgery was conducted from the side with heavier lesions. First, the patient was routinely disinfected and draped. Then, 20 mL of 2% lidocaine solution (Disal Biological Pharmaceutical Co., Ltd., Xi'an, China, H61020713) was diluted in 20 mL sterile saline, and skin, subcutaneous and muscular anaesthesia was performed at the puncture point. A bilateral puncture needle was used to puncture the intervertebral foramen. After confirming that the needle was in place, it was pulled out. Thereafter, the lesion in the intervertebral space was sawn through the dilated duct with a ring saw, the work string-casing annulus was placed, the percutaneous endoscope was attached, and the normal saline

lavage solution channel was opened to begin the endoscopic operation. With the aid of nucleus pulposus forceps, curved forceps, osteotome, and grinding drills, the necrotic tissues at different locations were removed, the dead bone was cleaned and the nerve roots were released, followed by the conduction of radiofrequency hemostasis and intradiscal electrothermal annuloplasty (IDET). Lesions on the other side were carefully removed after those on one side were cleared. Upon the completion of lesion removal, the prepared lavage and drainage tube was placed, and the catheterization process was guided directly under the endoscope. The drainage tubes were fixed, and 2 were confirmed to be unobstructed during the operation. After the operation, the patients were rinsed with 480,000 units of normal saline (1,000 mL) plus gentamicin sulphate (G-Clone Biotechnology Co., Ltd., Beijing, China, ABT344-500 mg), and the lavage liquid was > 3,000 ml/d. The changes of pus and necrotic substances in the drainage fluid were then observed after several days of lavage. If there was a decrease, the flushing volume was reduced to 2,000 mL/d. The drainage tube was kept unblocked. The stitches were removed and extubation was conducted when the washing solution was clear without purulent and bloody substances flowing out and the perfusion time was over 14 days. The inlet was removed first, and the outlet and stitches were then removed if the discharge was less than 30 mL/12 h after 24 hours or so.

Outcome measures

Surgical indexes: The intraoperative blood loss and postoperative drainage were observed in both groups.

Biochemical indexes: C-reactive protein (CRP), white blood cell count (WBC), and erythrocyte sedimentation rate (ESR) were compared before and after operation to evaluate the infection control of patients in the two groups.

Patient pain degree before, 1 month and 3 months after surgery was assessed using Visual analogue scale (VAS) [14], with a full score of 0-10 points. The score was in direct proportion to the severity of pain.

Oswestry dysfunction Index score [15] was adopted to evaluate the lumbar spine function of patients in the two groups before, 1 month and 3 months after surgery, with the index ranging from 0 to 100%. Evaluation: 0-20%: mild impairment, 21-40%: moderate impairment, 41-60%: severe impairment, 61-80%: crutch claudication, 81-100%: inability to get out of bed. The score was inversely proportional to lumbar function.

The neurological function of patients was evaluated by ASIA classification [16], which was divided into Grades A, B, C, D and E. Grade A: complete damage without any sensorimotor function in the sacral segment. Grade B: incomplete damage, with sensory function below the nerve plane, including the sacrum (S4 and S5 segments), but no motor function. Grade C: presence of motor function below the nerve plane, and the strength of most key muscles is less than Level 3. Grade D: presence of motor function below the nerve plane, and most key muscles have greater strength than or equal to Level 3. Grade E: normal sensory and motor function.

Postoperative complications in the two groups were observed and recorded.

The pre- and postoperative QOL of patients was determined by Short-Form 36 Item Health Survey (SF-36) [17] from the dimensions of physical functioning (PF), role-physical (RP), bodily pain (BP), vitality (VT), role-emotional (RE), mental health (MH), social functioning (SF) and general health (GH). The score was in direct proportion to the patient's QOL.

Statistical methods

SPSS 22.0 (Beijing Boaoyijie Technology Co., Ltd., China) was used for statistical analysis. Expressed by the number of cases/percentage (n/%), the counting data were compared by the Chi-square test between groups. When the theoretical frequency in chi-square test was less than 5, the continuous correction Chi-square test was applied. Mean ± standard deviation (mean ± SD) was used to represent the measurement data, and the comparison between groups or within the group was realized by the independent sample t-test or the paired t-test. GraphPad Prism 6 was used to visualize the data. Significance was determined when probability (*P*) values were less than 0.05.

Table 1. Comparison of general data between the two groups [n (%)]/(mean ± SD)

Classification	RG (n = 87)	CG (n = 69)	t/χ^2 value	*P* value
Gender			0.113	0.736
Male	54 (62.07)	41 (59.42)		
Female	33 (37.93)	28 (40.58)		
Average age (years old)	39.65±3.54	40.54±3.59	1.550	0.123
BMI (kg/m^2)	22.79±1.23	23.08±1.26	1.447	0.150
Course of disease (year)	3.34±1.04	3.56±1.09	1.285	0.201
Residence			0.832	0.362
Urban	48 (55.17)	33 (47.83)		
Rural	39 (44.83)	36 (52.17)		
Ethnicity			0.972	0.324
Han	41 (47.13)	38 (55.07)		
Ethnic minorities	46 (52.87)	31 (44.93)		
Educational background			3.535	0.060
≥ High school	42 (48.28)	23 (33.33)		
< High school	45 (51.72)	46 (66.67)		
Smoking history			2.775	0.096
Yes	65 (74.71)	43 (62.32)		
No	22 (25.29)	26 (37.68)		
Drinking history			0.358	0.549
Yes	57 (65.52)	42 (60.87)		
No	30 (34.48)	27 (39.13)		
Diabetes mellitus			1.192	0.275
Yes	39 (44.83)	37 (53.62)		
No	48 (55.17)	32 (46.38)		
Diet			0.090	0.764
Light	37 (42.53)	31 (44.93)		
Spicy	50 (57.47)	38 (55.07)		

Table 2. Comparison of surgical indexes between the two groups (mean ± SD)

Groups	n	Intraoperative blood loss (mL)	Hospital stay (d)	Postoperative drainage volume (mL)
RG	87	62.45±5.32	50.34±4.23	30.31±2.24
CG	69	87.36±7.04	96.42±7.46	78.54±4.45
T	-	25.170	48.620	88.050
P	-	< 0.001	< 0.001	< 0.001

Results

General information

Significant differences were absent in gender, average age, body mass index (BMI), course of disease, residence, ethnicity, educational background, smoking history, drinking history, diabetes, diet and other general clinical data between the RG and the CG (P > 0.05) (**Table 1**).

Comparison of surgical indexes

The intraoperative blood loss and postoperative drainage volume of patients in the RG were statistically lower than those in the CG (P < 0.05) (**Table 2**).

Comparison of biochemical indexes

The biochemical indexes represented by CRP, ESR and WBC showed no marked differences between the RG and CG before operation (P > 0.05). After operation, CRP, ESR and WBC improved significantly in both groups, and the levels in the RG were significantly lower than those in in the CG (P < 0.05) (**Table 3**).

Comparison of VAS scores

The preoperative VAS score did not identify any remarkable difference between the RG and the CG (P > 0.05). At different time points after operation, the VAS score improved significantly in both groups, and the VAS score at 1 month and 3 months after surgery was notably lower in the RG than in the CG (P < 0.05) (**Figure 1**).

Comparison of Oswestry dysfunction index scores

The preoperative Oswestry score differed insignificantly between the two groups (P > 0.05). One month after surgery, the Oswestry score of the two groups increased, but decreased with the passage of time (P < 0.05), and the score in the RG were significantly lower than those in the CG at 1 month and 3 months after surgery (P < 0.05) (**Figure 2**).

Table 3. Comparison of surgical indexes between the two groups (mean ± SD)

Groups	n	CRP (mg/L)		ESR (mm/h)		WBC (10^9/L)	
		Before operation	After operation	Before operation	After operation	Before operation	After operation
RG	87	45.65±3.65	10.35±2.04	48.53±3.54	9.64±1.37	8.87±1.32	2.45±0.54
CG	69	45.90±3.68	22.43±2.65	48.69±3.58	17.43±2.65	8.93±1.36	3.79±0.65
T	-	0.423	32.170	0.279	23.721	0.278	14.060
P	-	0.673	< 0.001	0.781	< 0.001	0.781	< 0.001

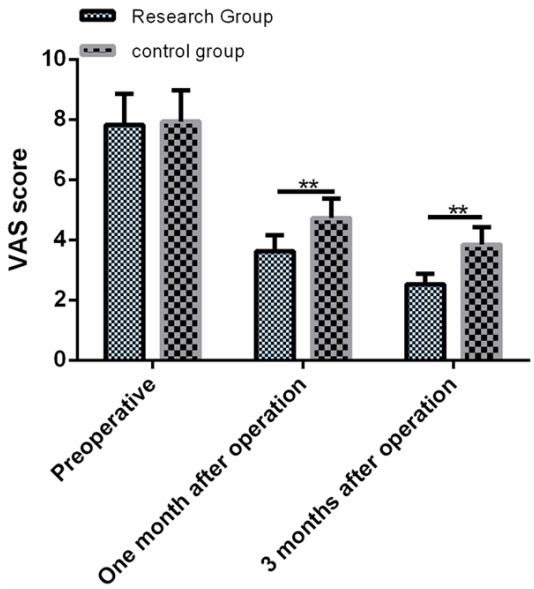

Figure 1. Comparison of VAS scores between the two groups in different time periods before and after operation. There was no significant difference in the VAS score between the two groups before operation, but the VAS score in the RG was significantly lower than that in the CG 1 month and 3 months after operation. Note: * indicates P < 0.05 compared with the preoperative level, ** indicates P < 0.01 compared between the two groups.

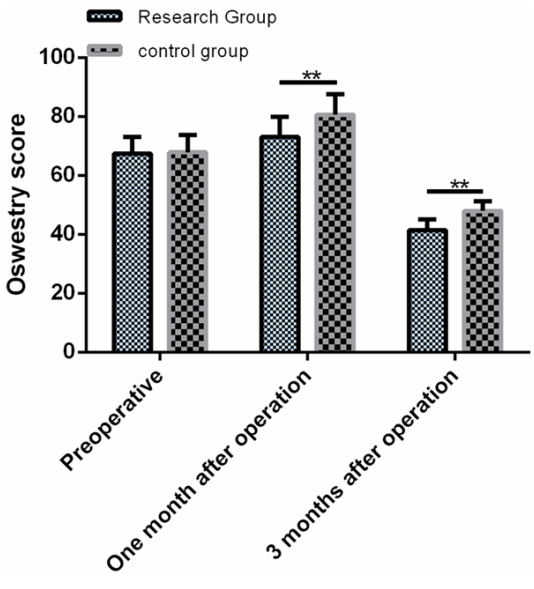

Figure 2. Comparison of Oswestry dysfunction index scores between the two groups in different time periods before and after operation. There was no significant difference in the Oswestry score between the two groups before operation, but the Oswestry score in the RG was significantly lower than that in the CG 1 month and 3 months after operation. Note: * indicates P < 0.05 compared with the preoperative level, ** indicates P < 0.01 compared between the two groups.

Comparison of postoperative ASIA classification

Before surgery, there were no patients with grade A or B, and the number of cases with grade C, D and E did not differ statistically between the RG and the CG (P > 0.05). After operation, the number of patients with grade C and D in the RG was observably lower than that in the CG, while the number of patients in grade E was evidently higher than that in the CG (P < 0.05) (**Table 4**).

Comparison of the incidence of postoperative complications

The total incidence of postoperative complications was 4.60% in the RG and 20.29% in the CG. Comparison of the total incidence of complications between the two groups showed that the total incidence of complications in the RG was significantly lower than that in the CG the control group (P < 0.05) (**Table 5**).

Comparison of SF-36 scores

In regard to the QOL of patients, there were no significant differences in physical functioning (PF), role-physical (RP), bodily pain (BP), vitality (VT), role-emotional (RE), mental health (MH), social functioning (SF) and general health (GH) between the two groups in SF-36 scores before operation. The SF-36 score improved in both groups after operation, and the scores of PF, RP, BP, VT, RE, MH, SF and GH in the RG were

Table 4. Comparison of postoperative ASIA classification between the two groups [n (%)]

Before operation	n	Grade A	Grade B	Grade C	Grade D	Grade E
RG	87	0 (0.00)	0 (0.00)	16 (18.39)	48 (55.17)	23 (26.44)
CG	69	0 (0.00)	0 (0.00)	15 (21.74)	37 (53.62)	17 (24.64)
χ^2	-	-	-	0.271	0.037	0.065
P	-	-	-	0.603	0.847	0.798
After operation	n	Grade A	Grade B	Grade C	Grade D	Grade E
RG	87	0 (0.00)	0 (0.00)	4 (4.60)	6 (6.90)	77 (88.51)
CG	69	0 (0.00)	0 (0.00)	11 (15.94)	18 (26.09)	40 (57.97)
χ^2	-	-	-	5.698	10.891	19.141
P	-	-	-	0.017	0.001	< 0.001

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

Classification	RG (n = 87)	CG (n = 69)	χ^2	P
Hematoma	1 (1.15)	3 (4.35)	1.576	0.209
Sinus formation at the catheter site	0 (0.00)	2 (2.90)	2.554	0.110
Cross infection	0 (0.00)	3 (4.35)	3.857	0.049
Local pain	1 (1.15)	2 (2.90)	0.624	0.429
Fever	2 (2.30)	4 (5.80)	1.273	0.259
Total incidence	4 (4.60)	14 (20.29)	9.283	0.002

Table 6. Quality of life scores before and after surgery in the two groups (mean ± SD)

Groups	PF		RP		BP		VT	
	Before operation	After operation	Before operation	After operation	Before operation	After operation	Before operation	After operation
RG (n = 87)	55.74±4.65	71.54±6.45	64.35±5.86	80.54±7.43	43.24±3.65	56.63±4.32	56.34±4.3.1	63.35±5.34
CG (n = 69)	56.02±4.57	63.34±5.87	64.87±5.79	73.25±7.24	44.15±3.53	51.35±4.21	55.76±4.39	60.14±5.26
T	0.376	8.204	0.553	6.155	1.569	7.667	0.828	3.754
P	0.707	< 0.001	0.581	< 0.001	0.119	< 0.001	0.409	0.002
Groups	RE		MH		SF		GH	
	Before operation	After operation	Before operation	After operation	Before operation	After operation	Before operation	After operation
The RG (n = 87)	56.34±4.26	66.65±5.67	68.43±5.79	76.45±6.04	66.85±5.64	79.43±6.03	54.65±4.34	65.80±5.03
CG (n = 69)	55.96±4.28	62.23±5.35	67.45±5.83	73.32±6.08	66.94±5.68	75.89±6.05	53.97±4.38	61.47±5.08
T	0.552	4.957	1.047	3.205	0.098	3.636	0.968	5.317
P	0.582	< 0.001	0.297	0.002	0.922	0.001	0.335	< 0.001

significantly higher than those in the CG ($P < 0.05$) (**Table 6**).

Discussion

PS is mainly caused by blood-borne infection, followed by trauma and local spread [18, 19]. Of blood-borne infections, the infection of single pathogenic bacteria is more common, which is clinically related to having diabetes, low immunity of the body or other infections; and due to disease-inducing factors, the incidence of PS is increasing annually [20]. Conservative treatment and open surgery usually give priority to effective anti-infection measures. However, due to the disadvantages of traditional open surgery such as high perioperative complication rates, long surgery time, massive trauma and large amount of blood loss [21], finding effective treatments is of prime importance.

In this study, we used PED, lavage and drainage to intervene in patients with PS, and found that the prognosis of patients after treatment was enormously improved. In the study of Liu P et al. [22], the rate of multiple organ failure and the

ICU hospitalization time in patients with infectious pancreatic necrosis treated by percutaneous catheter drainage were statistically lower than those in the open necrosis group. This study revealed that the intraoperative blood loss and postoperative drainage volume of patients in the RG were statistically lower than those in the CG, indicating that PED, lavage and drainage resulted in less trauma and clear intraoperative improvement in the treatment of PS, resulting in decreased operative time, reduced bleeding volume and postoperative drainage time. ESR is a sensitive experimental indicator of PS, and serum CRP is significantly increased in most patients with spinal infection [23]. According to Fu TS et al. [24], PED and drainage in patients with early infectious spondylitis could restore the expression of CRP in serum to normal within 2 to 22 weeks, without postoperative complications. Similar results were also obtained in this study; that is, compared with the CG, CRP, ESR and WBC levels were significantly reduced in the RG, indicating that PED, lavage and drainage can thoroughly remove the lesions and control the development of inflammation in the body, and reduce postoperative infection, which was the basis of successful operation. Previously, Wu D et al. [25] reported that bilateral or unilateral PED and lavage for patients with lumbar tuberculosis could reduce VAS and Oswestry scores at 6 and 18 months after surgery. Hence, VAS scores and Oswestry dysfunction index scores were introduced for the evaluation of patients' pain degree and lumbar functional recovery at different time points before and after operation. In line with the findings of Wu D et al., we found that VAS and Oswestry scores in the RG were statistically lower than those in the CG 1 and 3 months after operation, indicating that PED, lavage and drainage caused less trauma to the patients, alleviated postoperative pain, and retained the stable function of the lumbar spine to the greatest extent.

Infection can cause neuronal death in patients with spinal cord injury and limit their recovery of neurological function [26]. In the present study, the ASIA classification was employed for the assessment of patients' neurological function recovery before and after surgery. The results showed that after surgery, the number of patients with grades C and D in the RG was statistically lower while the number of patients with grade E was evidently higher in comparison with the CG, indicating that PED, lavage and drainage can reconstruct the stability of the upper cervical vertebra and effectively removed the lesions and decompression of the neural tube. Smith IB et al. [27] suggest that endoscopic drainage for patients with external wall necrosis of the pancreas is a feasible method with high clinical success rate and few complications. Also, we compared the postoperative complication rate between the RG and the CG. Consistent with the findings of Smith IB et al., we observed that the total incidence of complications in the RG was statistically lower than that in the CG, suggesting that PED, lavage and drainage can effectively remove lesions with little postoperative trauma and wounds, which underlay a lower incidence of postoperative infection and complications. Evidence has shown [28] that spondylitis is a chronic and progressive autoimmune inflammatory disease, which not only limits the mobility of the spine, but leads to irreversible structural changes, ultimately resulting in damage to the body function and decline in the QOL of patients. We observed that the scores of postoperative QOL were remarkably higher in the RG than in the CG, indicating that PED, lavage and drainage could effectively reduce the incidence of postoperative infection in patients with PS, effectively promote the recovery of the spine and wound, thereby meliorating the postoperative QOL of the patients.

Although this study has confirmed that PED, lavage and drainage is a feasible treatment for PS, there is still room for improvement. In the follow-up, we can supplement the analysis regarding the factors affecting the patient prognosis, and the postoperative recurrence rate can be recorded to explore the factors leading to recurrence. In addition, it is necessary to extend the research time and add patient follow-up after surgery to further corroborate the results of this research.

Taken together, PED, lavage and drainage in patients with PS can reduce infection, facilitate the recovery of lumbar function and neurological function, and meliorate the postoperative QOL of patients.

Disclosure of conflict of interest

None.

Address correspondence to: Zuoji Feng, Department of Orthopaedics, Huangdao District Chinese Medicine Hospital, 158th Hainan Island Road, Qingdao 266500, Shandong, China. Tel: +86-0532-86858887; E-mail: jianpxqbxbh330342@163.com

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