Am J Transl Res 2026;18(2):902-913
www.ajtr.org /ISSN:1943-8141/AJTR0169960

Original Article

Evaluation of the efficacy and safety of unilateral biportal endoscopic technique for the treatment of infectious spondylitis

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Received November 12, 2025; Accepted January 12, 2026; Epub February 15, 2026; Published February 28, 2026

Abstract: Objectives: To compare the efficacy and safety of unilateral biportal endoscopic technique (UBE) and percutaneous endoscopic debridement, irrigation, and drainage for infectious spondylitis, and provide evidence for clinical decision-making. Methods: A retrospective study included 108 patients (February 2023-May 2024) divided into a biportal group (n=54, UBE) and single portal group (n=54, percutaneous endoscopic surgery). Surgery-related indicators, inflammatory markers (ESR (erythrocyte sedimentation rate), CRP (C-reactive protein), TNF-α (tumor necrosis factor-α)), VAS (visual analog scale), ODI (Oswestry disability index), Kirkaldy-Willis score, Cobb angle, and bacterial culture positive rate were compared. Multiple linear regression analyzed factors influencing postoperative 120-day ESR. Results: The biportal group had longer surgical duration, drainage time, and more fluoroscopy (all $P<0.05$). No significant differences were found in VAS, ODI, Cobb angle, Kirkaldy-Willis excellent-good rate, or bacterial culture positive rate (all $P>0.05$). ESR, CRP, TNF-α in biportal group were lower at 90 and 120 days postoperatively ($P<0.05$). UBE and preoperative ESR were independent factors for 120-day ESR ($P<0.05$). Conclusions: UBE and percutaneous endoscopic surgery have comparable efficacy in relieving pain, improving function, correcting deformity, and pathogen detection. UBE provides better long-term inflammatory control, and surgical choice should consider disease complexity, surgeon proficiency, and need for inflammatory control.

Keywords: Infectious spondylitis, unilateral biportal endoscopic technique; visual analog scale, percutaneous endoscopic debridement and drainage, Oswestry disability index

Introduction

Infectious spondylitis is an inflammatory disease of the spinal structures caused by bacterial, fungal, or other microbial infections, characterized by infectious destruction of the vertebral bodies and intervertebral discs. The disease can directly infect spinal structures through the bloodstream or spread from adjacent infected tissues [1-3]. Common pathogenic microorganisms include *Staphylococcus aureus, Streptococcus species, Klebsiella pneumoniae, and Mycobacterium tuberculosis*. Patients typically present with persistent back pain, fever, local swelling, tenderness, and restricted mobility [4]. With disease progression, vertebral osteolysis and collapse may occur, resulting in spinal instability and, in severe cases, paraplegia. Traditional treatments comprise primarily antibiotic therapy and surgical intervention, while conventional surgery often causes the risk of obvious trauma and complications following surgery [5]. Therefore, there is a critical demand for more effective and safer treatments.

Traditional treatment plans for infectious spondylitis mainly include antibiotic therapy and surgical intervention. Antibiotic therapy, as the basic treatment for infectious diseases, controls the proliferation and spread of pathogenic microorganisms through oral or intravenous administration of antibiotics [6, 7]. However, due to the difficulty of delivering antibiotics to the infected site in sufficient concentrations, its therapeutic effect is often limited [8]. Therefore, surgical intervention becomes a necessary option when patients present with severe

https://doi.org/10.62347/PNNX9426

neurological deficits, spinal instability, or failure of conservative treatment. Traditional surgeries are mostly performed through open surgery, including vertebral resection, and intervertebral fusion. According to previous studies, these traditional open surgeries have the following significant shortcomings: Greater trauma: The surgical incision is long, and extensive stripping of paravertebral muscles and soft tissues is required, causing significant damage to the normal anatomical structures around the spine, which can easily lead to muscle atrophy and residual low back pain after surgery; Higher intraoperative blood loss: During the exposure of the surgical field in open surgery, the risk of vascular injury is high, and excessive blood loss may cause anemia, electrolyte disturbances, and other complications, increasing the surgical risk; Higher postoperative complication rate: Due to severe soft tissue injury, the risk of postoperative complications such as incision infection, subcutaneous hematoma, and cerebrospinal fluid leakage is significantly increased. Longer bed rest for recovery can easily result in systemic complications (deep vein thrombosis, pulmonary infection, etc.); Longer recovery period: The surgical trauma generates obvious damage to the patient's body, and a longer duration of bed rest is required following surgery. This prolongs the hospital stay, and may influence the recovery of spinal function, reducing the patient's postoperative quality of life; Demonstrable effect on spinal stability: It is necessary for some traditional surgeries to remove a large number of vertebral bodies or pedicle bone, and the mechanical structure of the spine may be damaged, increasing the possibility of postoperative worsening of spinal deformity [9]. Along with the continuous advancement of medical technology, the unilateral biportal endoscopic (UBE) spine surgery, as a minimally invasive surgical approach, has obtained more attention. This technique adopts an endoscope to carry out surgery within the spine, which maximizes the preservation of vertebral structure integrity and minimizes damage to surrounding tissues [10-12]. Through UBE, surgeons make a minimally invasive incision on the affected side, clearing the infection, repairing vertebral bone, and performing interbody fusion by means of endoscopic manipulation. This method noticeably reduces surgical trauma and blood loss, and shortens postoperative recovery duration. Because it avoids unnecessary damage to normal tissues, the occurrence of postoperative complications is reduced, improving quality of life [13, 14].

UBE spinal surgery has helped to treat infectious spondylitis. It achieves spinal internal surgery employing endoscopic operation, which maximally maintains the integrity of the vertebral body structure and reduces surrounding tissue damage. However, there is a need to further validate the long-term efficacy and safety of this technique for infectious spondylitis through clinical studies with larger sample sizes and longer follow-up periods in order to better define the clinical value and to offer it as an option to patients.

Materials and methods

Research subjects

This study was approved by the Ethics Committee of The First Affiliated Hospital of Hebei North University. The retrospective study comprised the medical records of 108 patients with infectious spondylitis visiting the First Affiliated Hospital of Hebei North University from February 2023 to May 2024. The allocation and the choice of surgical methods complied with the following standards:

1. The severity of the patient's condition: For patients with a wide range of infection, multiple foci of necrotic tissue, or severe vertebral destruction, UBE surgery was preferred, which had the advantage of thorough debridement and vertebral repair.

2. For patients with localized infection and no obvious vertebral structural destruction, percutaneous endoscopic debridement, irrigation, and drainage (single portal group) was chosen.

3. The individual condition of the patient: The patient's age, underlying disease status, and surgical tolerance were subjected to assessment. For patients who were older, had more underlying diseases and lower surgical tolerance, percutaneous endoscopic debridement, irrigation, and drainage, which was less traumatic and relatively simpler to operate, was preferred.

4. Shared decision-making between doctors and patients: Based on the patients' and their

Table 1. Comparison of basic clinical indicators between the two groups

Indicator	Biportal group (n=54)	Single portal group (n=54)	Statistical value	*P*
Age (years, x ± s)	48.25 ± 6.13	51.12 ± 8.36	*t*=-1.982	0.051
Gender (cases, male/female)	31/23	33/21	χ^2=0.154	0.695
Duration of disease (months, x ± s)	3.21 ± 1.05	3.45 ± 1.12	*t*=-1.126	0.263
Affected segments (cases)			χ^2=0.873	0.832
Cervical vertebrae	4	3		
Thoracic vertebrae	15	17		
Lumbar vertebrae	30	29		
Multi segments (noncontiguous)	5	5		
Underlying disease (cases, yes/no)	18/36	20/34	χ^2=0.167	0.683
Diabetes	8	9		
Hypertension	7	8		
Chronic kidney disease (non-end-stage)	2	2		
Others (e.g., chronic lung disease)	1	1		
Preoperative body temperature (°C, x ± s)	37.52 ± 0.41	37.61 ± 0.38	*t*=-1.158	0.249
Preoperative neurological symptoms (cases, yes/no)	12/42	10/44	χ^2=0.254	0.614
Numbness in the lower limbs	7	6		
Decreased muscle strength (≤ grade 4)	4	3		
Urinary and bowel dysfunction	1	1		

families' expectations for surgical efficacy and postoperative recovery needs, the final surgical plan was jointly determined after fully informing them of the advantages and disadvantages of the two surgical methods.

According to the above principles, the patients were allocated to a biportal group (54 cases, undergoing UBE surgery) or a single portal group (54 cases, undergoing percutaneous endoscopic debridement, irrigation, and drainage). The comparative results of the basic clinical data of the two groups of patients are shown in **Table 1**, and there were no statistical differences in the indicators between the groups (*P*>0.05).

Inclusion criteria were: i) patients with no improvement following conventional treatment; ii) patients who had not undergone prior surgery on the lumbar spine; iii) patients with clear consciousness and the ability to communicate normally; iv) patients with complete baseline data.

Exclusion criteria were: i) patients unable to tolerate surgery; ii) patients with severe multi-segmental lesions; iii) patients with lumbar spine deformities; iv) patients with missing follow-up data.

Two treatment plans

Patients in the biportal group underwent UBE spine surgery, while those in the single portal group received percutaneous endoscopic debridement, irrigation, and drainage.

UBE spine surgery was as follows: i. On the day of surgery, patients underwent preoperative preparations, including fasting, skin disinfection, and general anesthesia. ii. The precise location of the infection was identified under X-ray guidance, and the surgical incision site was determined. A minimally invasive incision was created on the affected side of the patient's back, and a unilateral biportal approach was established. One portal was used for introducing the endoscope and surgical instruments, and the other for drainage and inserting auxiliary equipment. iii. Introduction of surgical instruments was carried out through the biportal endoscope for removing infected vertebral tissue, containing abscesses and necrotic tissue. Vertebral repair was conducted adopting vertebral fillers depending on the extent of vertebral damage. iv. At the end of the surgery, a drainage tube was inserted by the auxiliary portal, aiming to expel potential postoperative secretions, and then a layered closure of the incision was carried out.

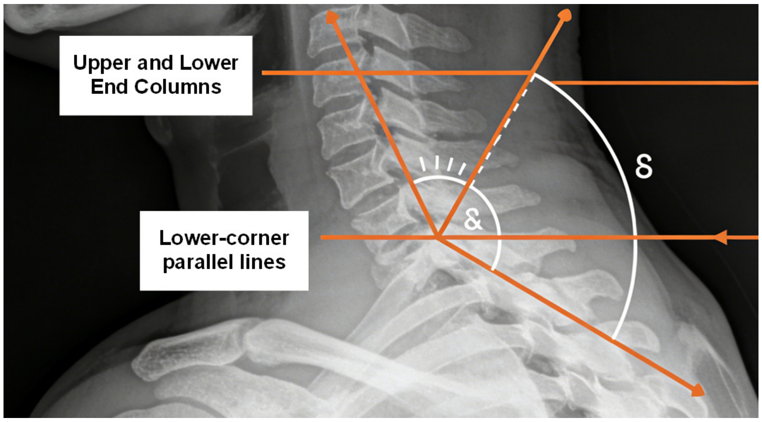

Figure 1. Schematic diagram of Cobb angle measurement. Note: The orange solid lines correspond to the endplates of the superior border of the upper-end vertebra and the inferior border of the lower-end vertebra in scoliosis, respectively. The white dashed line is parallel to the inferior endplate. The angle formed between the two orange solid lines and the white dashed line (marked as δ in the figure) is the Cobb angle.

Percutaneous endoscopic debridement, irrigation, and drainage procedure: i. Patients underwent preoperative preparations (fasting, fluid restriction, and skin disinfection), and to alleviate pain, local anesthesia was implemented. ii. Using X-ray imaging technology, the location of the lesion that was caused by spondylitis was determined, and the surgical incision site was subjected to marking. Following identifying the incision location, the skin was incised. iii. Insertion of an endoscope into the lesion site of spondylitis provided a clear surgical field of view. Subsequently, surgical instruments that were introduced through the endoscope were used for the endoscopic removal of spondylitis lesions (inflammatory tissue and abscesses). Following the debridement, the next step was irrigation, to cleanse the surgical area. iv. Drainage tubes or drainage devices were placed to drain any secretions, which may accumulate in the surgical area, to maintain cleanliness and dryness. Finally, closing the incision was implemented layer by layer to promote wound healing.

Efficacy data collection

Recording the details of pathological types, surgical duration, drainage time, and intraoperative fluoroscopy times of all patients ensured the completeness and accuracy of the basic surgical data. The erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and tumor necrosis factor-α (TNF-α) levels of the patients were measured prior to the operation and 30 days, 60 days, 90 days and 120 days following the operation, which aimed to dynamically monitor the changes in the patients' inflammatory status. The following standardized assessment tools and testing methods were used to conduct the evaluation of the relevant indicators:

(1) Visual analog scale (VAS): Used for the assessment of pain intensity. A 10-point scale is used, with 0 representing no pain and 10 representing the most severe pain. Patients were asked to mark the corresponding score on the scale according to their own pain sensation to evaluate the pain intensity in both resting and active states. The average of the two assessments was obtained as the final VAS score.

(2) Oswestry disability index (ODI): It was used to assess the degree of spinal dysfunction. The scale includes 10 dimensions: pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sexual life, social life, and traveling, with each dimension scored from 0 to 5 and the total score ranging from 0 to 50. The higher the score, the more severe the functional impairment. The patients were asked to independently complete the scale and then the total score was calculated.

(3) Kirkaldy-Willis functional score: It was used to comprehensively evaluate the recovery of spinal function. The assessment was conducted from four dimensions: pain, functional activity, working ability, and neurological function, with a total score of 100 points. Scores of 90-100 were rated as excellent, 75-89 as good, 60-74 as fair, and less than 60 as poor. The scores were independently assessed by two experienced orthopedic surgeons and the average was obtained. The excellent and good rate was calculated as (the number of excellent and good cases/the total number of cases) × 100%.

(4) Thoracolumbar Cobb angle measurement (**Figure 1**): Based on preoperative and postop-

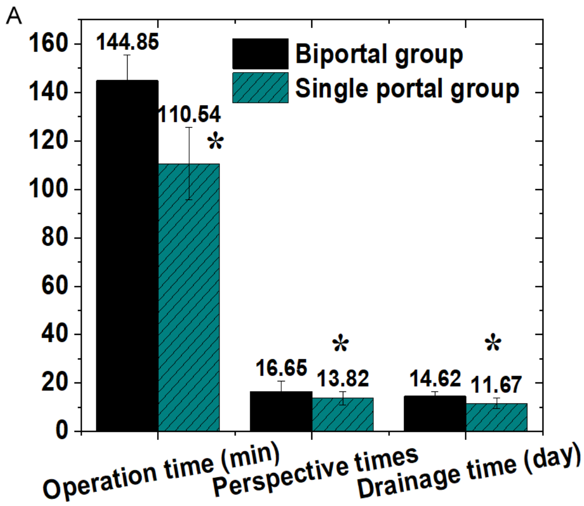

Figure 2. Comparison of pathological typing, surgical duration, drainage time, and intraoperative fluoroscopy times between the two groups. (A: Surgical duration, drainage time, and intraoperative fluoroscopy times; B: Pathological typing). Note: *P<0.05 between the biportal and single portal groups.

erative thoracolumbar anteroposterior X-ray films at various time points, the measurements were independently performed by two radiologists using a blinded method. The method of measurement was as follows: First, the upper end vertebral body of the scoliosis (the one with the largest angle between the perpendicular line of the upper edge endplate and the midline of the spine) and the lower end vertebral body (the one with the largest angle between the perpendicular line of the lower edge endplate and the midline of the spine) were determined. Parallel lines were drawn to the upper edge of the upper end vertebral body and the lower edge of the lower end vertebral body, respectively. Perpendicular lines were then drawn to these two parallel lines. The angle between the two perpendicular lines was the Cobb angle. If the difference between the two measurements was greater than 3°, a third physician would remeasure and the final value would be obtained. This was used to evaluate the improvement in spinal deformity.

(5) Drug sensitivity test: The infected focus tissue or pus samples obtained during the operation were collected and immediately sent to the laboratory for bacterial culture. The samples were inoculated onto blood agar medium and MacConkey medium and cultured in a 35°C, 5% CO_2 incubator for 18-24 hours to observe bacterial growth. For the positive strains in culture, the disk diffusion method (Kirby-Bauer method) was used to test drug sensitivity. The sensitivity of the strains to 12 commonly used antibiotics, including cephalosporins, quinolones, aminoglycosides, etc., was tested. The results were interpreted according to the standards set by the Clinical and Laboratory Standards Institute (CLSI) and were classified into susceptible, intermediate, and resistant. The drug-sensitivity spectrum of each strain was recorded to provide a basis for the clinical selection of antibiotics.

(6) Quality of life assessment: The 36-item Short Form Health Survey (SF-36) was used to assess the patients' quality of life. The scale includes eight dimensions: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health. Each dimension is scored from 0 to 100, with a total score ranging from 0 to 100. The higher the score, the better the quality of life. The patients were asked to complete the scale before the operation and 30 days, 60 days, 90 days, and 120 days after the operation. The scores of each dimension and the total score were calculated to evaluate comprehensively the effect of the operation on the patients' quality of life.

Statistical methods

Statistical analysis was conducted using SPSS version 19.0. Continuous variables were pre-

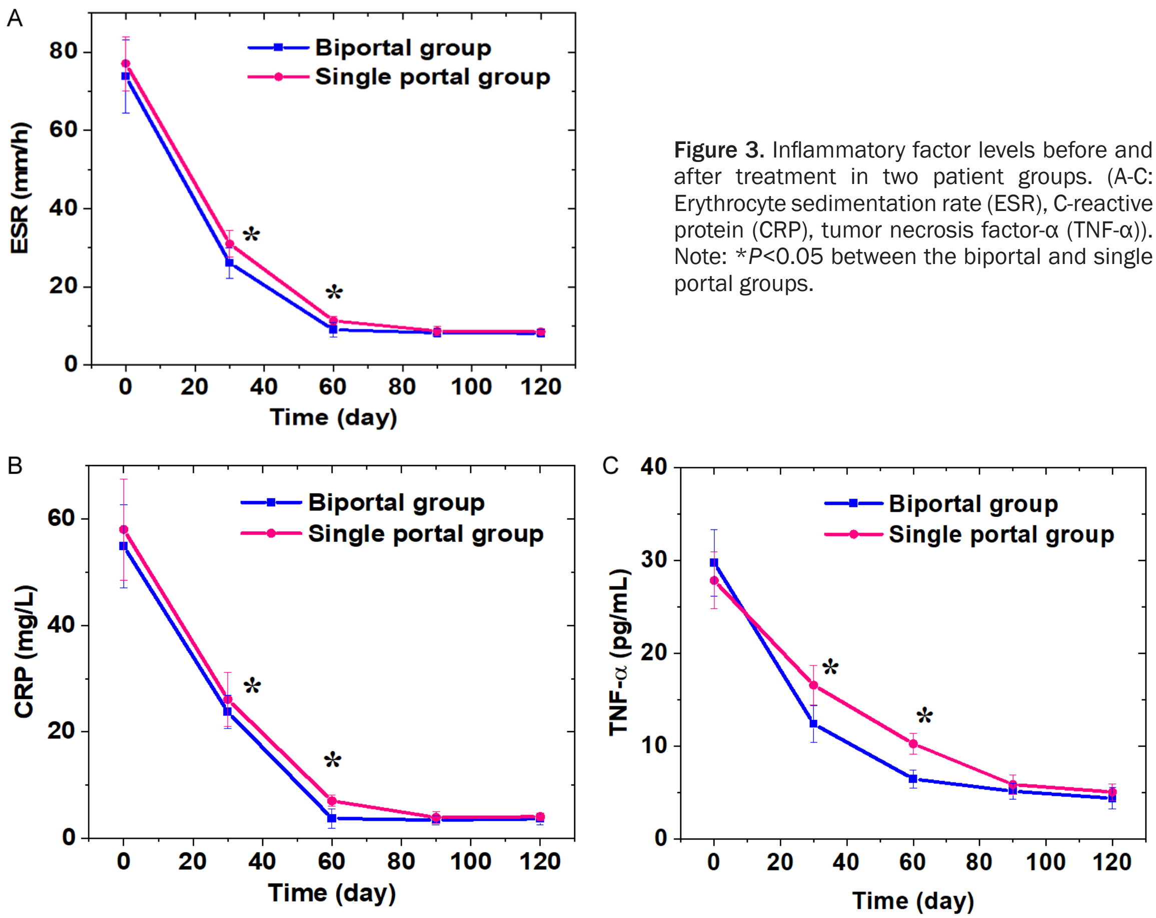

Figure 3. Inflammatory factor levels before and after treatment in two patient groups. (A-C: Erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), tumor necrosis factor-α (TNF-α)). Note: *P<0.05 between the biportal and single portal groups.

sented as mean ± standard deviation (mean ± s), and categorical data were expressed as percentages (%). Group comparisons were conducted employing repeated measures analysis of variance (ANOVA) for between-group analyses and two-way ANOVA for within-group analyses. Two-tailed tests were conducted, and differences were considered significant at P<0.05.

Results

The patient's surgical condition

In **Figure 2**, the surgical duration for patients in the biportal group was 144.85 ± 10.64 minutes, with an intraoperative fluoroscopy frequency of 16.65 ± 4.05 times, and drainage duration of 14.62 ± 1.78 days. Pathologic classification yielded 13 cases of central type, 10 cases of peripheral type, and 31 cases of mixed type. In the single portal group, the surgical duration was 110.54 ± 14.95 minutes, with an intraoperative fluoroscopy frequency of 13.82 ± 2.71 times, and drainage duration of 11.67 ± 2.25 days. Pathologic classification yielded 11 cases of central type, 9 cases of peripheral type, and 34 cases of mixed type. It can be observed that the surgical duration, drainage duration, and fluoroscopy frequency were significantly higher in biportal group versus single portal group (P<0.05). However, the pathologic classification showed a slight difference between the biportal and single portal groups (P>0.05).

Inflammatory cytokine levels in patients before and after treatment

Before surgery and at 30 and 60 days after surgery, there were no statistical differences in the levels of ESR, CRP, or TNF-α between the biportal group and the single portal group (P>0.05). However, at 90 and 120 days after surgery, the levels of ESR, CRP, and TNF-α in the biportal group were significantly lower than those of the single portal group (P<0.05), indicating that as the postoperative recovery time was extended, the advantages of UBE surgery in suppressing inflammatory reactions gradually emerged (**Figure 3**).

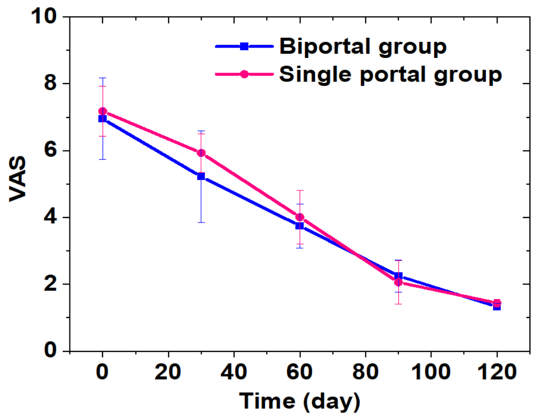

Figure 4. Comparison of pain VAS (visual analog scale) scores between the two groups of patients before and after treatment. Note: Comparisons between the two groups at each time point, *P*>0.05.

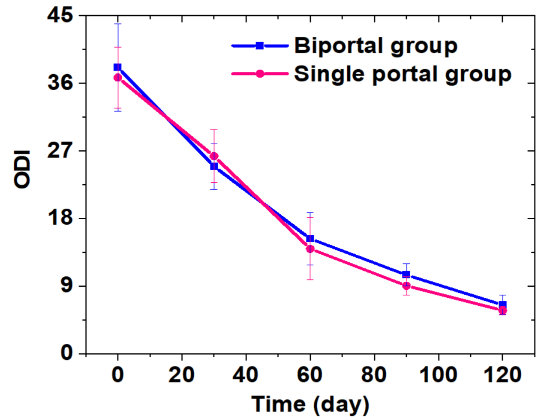

Figure 5. Comparison of ODI (Oswestry disability index) before and after treatment in the two patient groups. Note: Comparisons between the two groups at each time point, *P*>0.05.

VAS of pain for patients before and after treatment

In **Figure 4**, there were no statistically significant differences (*P*>0.05) in pain VAS scores between the biportal and single portal groups at baseline, or at 30, 60, 90, and 120 days post-surgery.

ODI of patient before and after treatment

In **Figure 5**, there were no significant differences (*P*>0.05) in ODI scores between the biportal and single portal groups at baseline, or at 30, 60, 90, and 120 days post-surgery.

Patient Kirkaldy-Willis functional score

According to the Kirkaldy-Willis functional score criteria (**Figure 6**), in the biportal group, there were 39 cases graded as excellent, 12 cases as good, and 3 cases as moderate, resulting in an excellent-to-good rate of 94.44%. In the single portal group, the corresponding cases were 34, 15, and 5, resulting in an excellent-to-good rate of 90.74%. Therefore, there were no significant differences (*P*>0.05) in the excellent-to-good rate of Kirkaldy-Willis functional scores between the biportal and single portal groups.

Cobb angle of thoracic and lumbar vertebrae before and after treatment for patients

In **Figure 7**, there were no statistically significant differences (*P*>0.05) in the thoracolumbar Cobb angle between the biportal and single portal groups at baseline, or at 30, 60, 90, and 120 days post-surgery.

Patient drug sensitivity test results

In **Figure 8**, among the 54 patients in the biportal group, bacterial growth was absent in 11 cases, while bacterial cultures were positive in 43 cases. Among the positive cultures, *Staphylococcus aureus* was found in 27 cases, *Klebsiella pneumoniae* in 9 cases, *Streptococcus pneumoniae* in 4 cases, *Escherichia coli* in 1 case, and *Salmonella* in 1 case. In the single portal group of 54 patients, bacterial growth was absent in 9 cases, while bacterial cultures were positive in 45 cases. Among the positive cultures, *Staphylococcus aureus* was found in 25 cases, *Klebsiella pneumoniae* in 12 cases, *Streptococcus pneumoniae* in 5 cases, *Escherichia coli* in 2 cases, and *Salmonella* in 1 case. In the biportal group (54 patients), 11 had negative bacterial cultures, and 43 had positive bacterial cultures, with a positive rate of 79.63%. In the single portal group (54 patients), 9 had negative bacterial cultures, and 45 had positive bacterial cultures, with a positive rate of 83.33%. There was no statistical difference in the positive rate of bacterial culture between the two groups of patients (*P*>0.05), indicating that the two surgical methods were similar for obtaining infected lesion samples and identifying pathogens during surgery.

Multivariate linear regression analysis of factors affecting ESR level at 120 days after surgery

To identify the key factors affecting the long-term postoperative inflammatory control (with

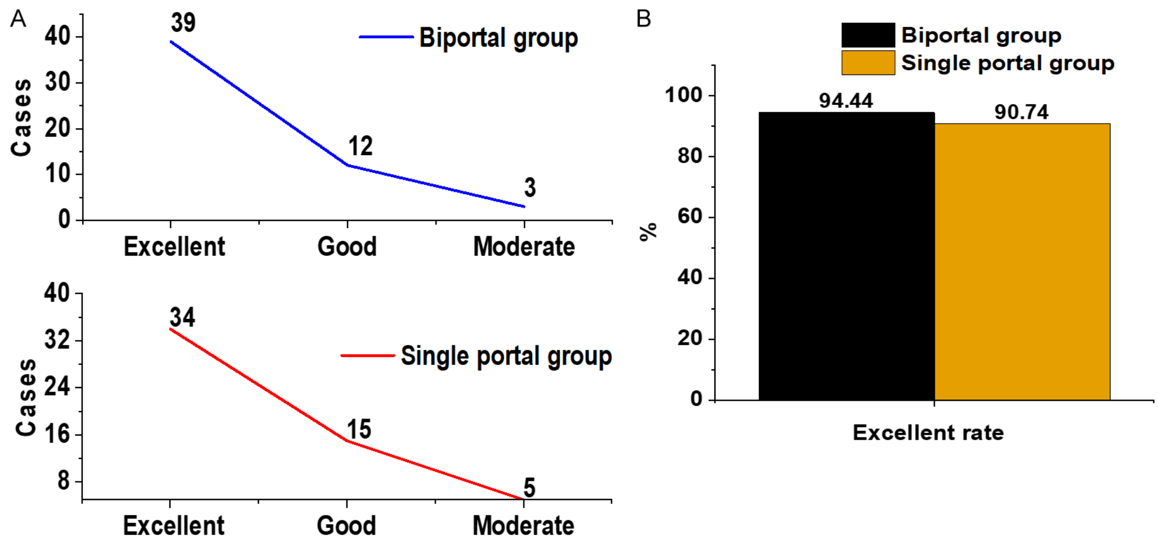

Figure 6. Comparison of Kirkaldy-Willis functional scores between the two groups of patients after treatment. (A: Represents the number of excellent, good, and moderate cases; B: Represents the excellent rate). Note: Comparison of the excellent and good rate between the two groups, *P*>0.05.

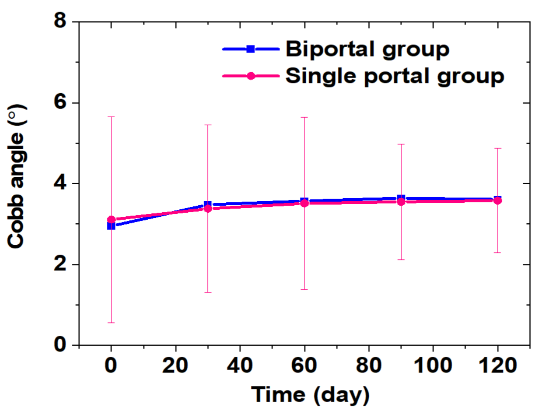

Figure 7. Contrast of the Cobb angles of the thoracic and lumbar vertebrae between the two groups of patients before and after treatment. Note: Comparisons between the two groups at each time point, *P*>0.05.

ESR at 120 days after surgery as the core evaluation indicator) in patients with infectious spondylitis, this study used multivariate linear regression analysis. The analysis included six potential influencing factors: surgical approach, age, disease duration, presence of underlying diseases, pre-operative ESR level, and surgical duration. The independent effects of each factor on the ESR level at 120 days after surgery were analyzed.

The results of the regression analysis are shown in **Table 2**. The regression model was statistically significant as a whole (R^2=0.386, adjusted R^2=0.342, *F*=8.792, *P*<0.001). Surgical approach and pre-operative ESR level had a significant effect on the ESR level at 120 days after surgery (both *P*<0.05). With percutaneous endoscopic debridement and drainage (single portal group) as the reference, the regression coefficient for UBE surgery (biportal group) was -8.623 (SE=2.154, *t*=-4.003, *P*<0.001), with a 95% CI of [-12.857, -4.389]. The regression coefficient for pre-operative ESR level was 0.418 (SE=0.123, *t*=3.398, *P*=0.001), with a 95% CI of [0.176, 0.660].

Age, disease duration, the presence of underlying diseases, and surgical duration had no significant effect on the ESR level at 120 days after surgery (all *P*>0.05): The regression coefficient for age was 0.125 (SE=0.089, *t*=1.404, *P*=0.164), with a 95% CI of [-0.051, 0.301]. The regression coefficient for disease duration was 0.352 (SE=0.217, *t*=1.622, *P*=0.108), with a 95% CI of [-0.078, 0.782]. The regression coefficient for the presence of underlying diseases was 1.205 (SE=1.891, *t*=0.637, *P*=0.525), with a 95% CI of [-2.528, 4.938]. The regression coefficient for surgical duration was 0.032 (SE=0.029, *t*=1.103, *P*=0.273), with a 95% CI of [-0.025, 0.089]. The constant term was 15.826 (SE=5.217, *t*=3.034, *P*=0.003), with a 95% CI of [5.538, 26.114].

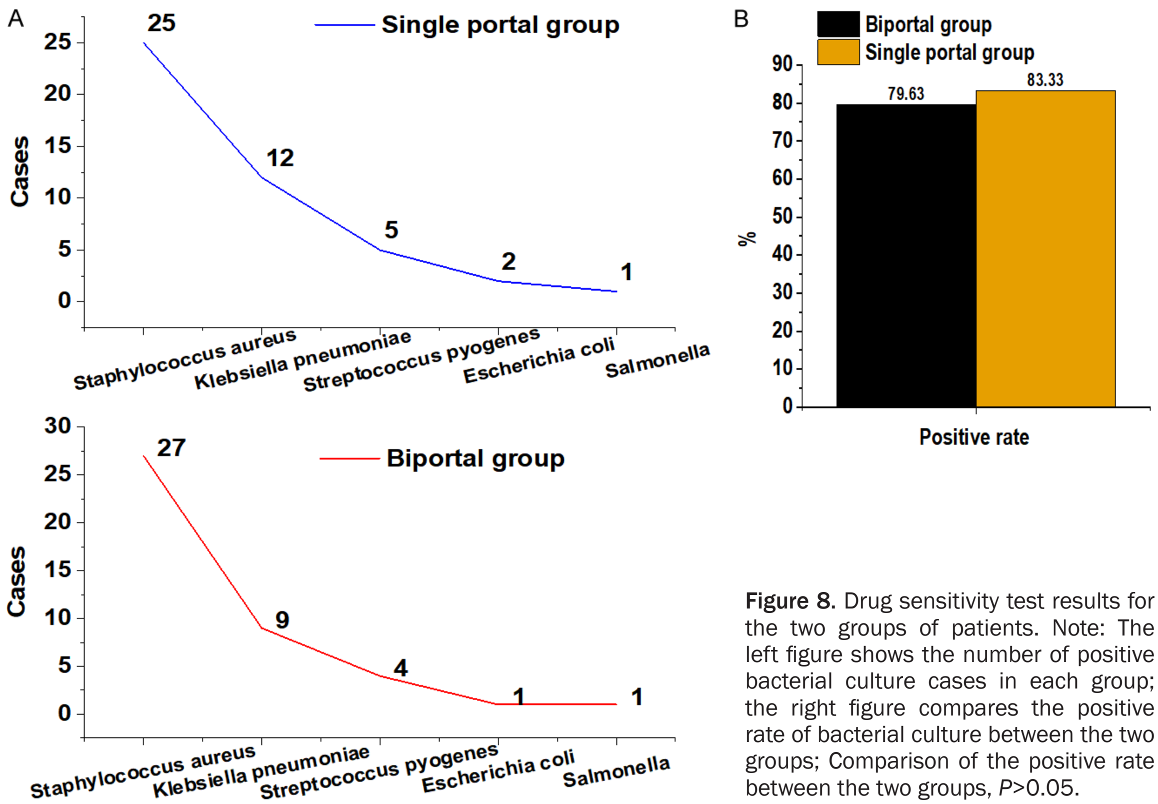

Figure 8. Drug sensitivity test results for the two groups of patients. Note: The left figure shows the number of positive bacterial culture cases in each group; the right figure compares the positive rate of bacterial culture between the two groups; Comparison of the positive rate between the two groups, *P*>0.05.

Table 2. Results of multivariate linear regression analysis of factors affecting ESR level at 120 days after surgery

Factor	Regression coefficient (β)	Standard error (SE)	*t*	*P*	95% CI
Surgical approach (UBE =1, single portal surgery =0)	-8.623	2.154	-4.003	<0.001	[-12.857, -4.389]
Age (years)	0.125	0.089	1.404	0.164	[-0.051, 0.301]
Disease duration (months)	0.352	0.217	1.622	0.108	[-0.078, 0.782]
Presence of underlying diseases (Yes =1, No =0)	1.205	1.891	0.637	0.525	[-2.528, 4.938]
Pre-operative ESR level (mm/h)	0.418	0.123	3.398	0.001	[0.176, 0.660]
Surgical duration (minutes)	0.032	0.029	1.103	0.273	[-0.025, 0.089]
Constant term	15.826	5.217	3.034	0.003	[5.538, 26.114]

Note: Model R^2=0.386, adjusted R^2=0.342, *F*=8.792, *P*<0.001.

Discussion

Infectious spondylitis is a spinal infectious disease resulting from bacteria or other pathogens, typically disseminating to the spinal bones and soft tissues through blood circulation or direct spread, and affecting the spine [15]. Treatment of infectious spondylitis can be challenging, varying based on the patient's condition. Infectious spondylitis can result in severe vertebral destruction, spinal deformities, and complications, such as surrounding soft tissue infections. There are necessary measures during treatment: addressing the source of infection and ongoing infection control. Furthermore, comorbidities or other health issues may exist in some patients, increasing the complexity of treatment [16-18]. Therefore, selecting scientifically rational treatment methods aimed at various patient circumstances is important. The present study retrospectively collected case data from 108 patients who were diagnosed with infectious spondylitis, and they were allocated to two groups based on treatment protocols: 54 patients in the biportal group (UBE spine surgery) and 54 patients in the single portal group (percutaneous endoscopic debridement, irrigation, and drainage). The biportal and single portal groups differed slightly regarding age, gender, and pathologic classification (*P*>0.05). No statistically significant differences in age, gender, or pathological classification were observed between the biportal and single portal groups, which was possibly attributable to chance factors [19].

The surgical duration, drainage duration, and fluoroscopy frequency were higher in the biportal group than the single portal group (*P*< 0.05). This may reflect the relatively complex surgical procedures of the biportal approach. Accordingly, prolonged surgical duration, increased drainage duration, and more fluoroscopy sessions were needed to ensure the accuracy and safety of the procedure [20, 21]. Discrepancies with previous studies may exist in differences in sample characteristics, study designs, or data analysis methods. Fu et al. (2019) [22] investigated the efficacy of percutaneous endoscopic debridement and drainage compared with traditional open anterior approach surgery for lumbar infectious spondylitis. They found that patients undergoing percutaneous endoscopic debridement and drainage showed noticeably faster normalization rates of CRP and ESR relative to those who underwent traditional open anterior approach surgery. Moreover, *Staphylococcus aureus* was identified as the most common pathogen among isolated causative microorganisms (38.2%). This study found that on postoperative days 90 and 120, BSR, CRP, and TNF-α had a substantial reduction in biportal group versus single portal group (*P*<0.05). It revealed that patients undergoing UBE spine surgery exhibited superior efficacy in alleviating systemic inflammation levels. Bacterial culture reports revealed positive cultures in 43 cases among the biportal group, *Staphylococcus aureus* as the most prevalent pathogen (27 cases), followed by *Klebsiella pneumoniae* (9 cases), *Streptococcus pneumoniae* (4 cases), *Escherichia coli* (1 case), and *Salmonella* (1 case). Among the single portal group, positive cultures were reported in 45 cases, and *Staphylococcus aureus* was the most prevalent pathogen (25 cases), followed by *Klebsiella pneumoniae* (12 cases), *Streptococcus pneumoniae* (5 cases), *Escherichia coli* (2 cases), and *Salmonella* (1 case). *Staphylococcus aureus* is one of the most common pathogens that have association with infectious spondylitis [23]. The effect of surgical approach on long-term postoperative inflammatory control was subjected to verification by multivariate linear regression analysis. The results showed that after controlling for potential confounding factors such as age, disease duration, underlying diseases, pre-operative ESR level, and surgical duration, UBE surgery could still significantly reduce the ESR level at 120 days after surgery (β=-8.623, *P*<0.001). This echoed the previous finding that "the inflammatory indicators at 90 and 120 days after surgery in the UBE group were significantly lower than those in the single portal group", confirming the independent advantage of UBE surgery in long-term inflammatory control from the perspective of influencing factors. Meanwhile, it was found that the pre-operative ESR level was positively correlated with the ESR level at 120 days after surgery (β=0.418, *P*=0.001), indicating that the degree of pre-operative inflammation is an important associated factor for postoperative inflammatory relief. Age, disease duration, the presence of underlying diseases, and surgical duration had no significant impact on the ESR level at 120 days after surgery (all *P*>0.05). This provides a data reference for the clinical selection of a suitable population for UBE surgery. For patients with higher degree of preoperative inflammation and the need for better long-term inflammatory control, UBE surgery may be the targeted choice. Findings also indicated negligible interference of age, underlying diseases, or other factors on the long-term inflammatory control effect of UBE surgery.

Pain assessment is an important medical evaluation method, which is used to assess the severity and type of pain experienced by patients. Through this assessment, doctors can more clearly understand the patients' condition, choose appropriate treatment plans and dynamically monitor the therapeutic effect. Nocturnal spinal pain, as an important source of burden for patients with spinal-related diseases, not only directly affects the quality of life of patients but also may be closely related to long-term prognosis. Ramiro et al. (2024) [24] in the Ixekizumab COAST-V randomized trial, which was conducted on patients with radiographic axial spondyloarthritis (r-axSpA), confirmed that clinically significant improvement

(≥3 points) in nocturnal spinal pain is closely related to the reduction of disease activity (ASDAS), improvement of functional status and health-related quality of life (SF-36). Moreover, this improvement can be maintained for up to 52 weeks, highlighting the important value of pain assessment (especially nocturnal pain) in judging disease prognosis. In this study, the overall pain status of patients was assessed using the VAS score. The results showed that there were no significant differences in pain VAS scores between the biportal group and the single portal group at baseline and at 30 days, 60 days, 90 days, and 120 days after the operation ($P>0.05$). This is consistent with the conclusion of Prétat et al. (2024) [25], indicating that there was no significant difference in pain perception during the recovery process between patients undergoing UBE spinal surgery and those undergoing percutaneous endoscopic debridement, irrigation, and drainage. It is worth noting that this study did not specifically conduct stratified analysis on nocturnal spinal pain. However, the COAST-V trial suggests that improvement in nocturnal pain may be an important predictor of long-term prognosis. Future studies may increase specialized assessment of nocturnal pain to further clarify the impact of the two surgical methods on patients' nocturnal pain and their association with long-term efficacy. This may be attributed to factors such as surgical type, postoperative management, and analgesic measures. Moreover, there were no significant differences ($P>0.05$) in thoracolumbar Cobb angle/ODI and Kirkaldy-Willis functional scores between the biportal and single portal groups at baseline, and at 30, 60, 90, and 120 days post-surgery. Tong et al. (2019) [26] noted similar findings, indicating similar effects of UBE spine surgery and percutaneous endoscopic debridement and drainage on patients' functional impairment and pain levels, with neglectable differences in clinical efficacy.

Conclusion

The UBE surgery and percutaneous endoscopic debridement, irrigation, and drainage were equally effective in relieving pain, improving spinal function, correcting deformity, and detecting pathogens for patients with infectious spondylitis. Although the UBE surgery had longer surgical duration, longer drainage time, and more intraoperative fluoroscopy times, it had better long-term postoperative inflammation control. The surgical method can be chosen according to the complexity of the patient's condition, the surgeon's technical proficiency, and the postoperative inflammation control requirements.

Acknowledgements

This work was supported by Medical Application Technology Tracking Project of Hebei Province (No. GZ2022068); Hebei Medical Science Research Project (20241026); 2024 Zhangjiakou City Level Science and Technology Plan Project (2421133D).

Disclosure of conflict of interest

None.

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