Section: Orthopaedics

Original Research Article

# MANAGEMENT AND CLINICAL OUTCOMES OF CERVICAL SPONDYLODISCITIS IN PATIENTS WITH AND WITHOUT NEUROLOGICAL DEFICITS BY ANTERIOR APPROACH: A COMPREHENSIVE STUDY

***Vidit Sonakia[1], Nazim Mughal[2], Ajay Kumar[3], Shalini Sharma[4], Gopal Tiwari[5], Vinay Aggarwal[6]***

*[1]Junior Resident (3rd year), Department of Orthopaedics, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India.*
*[2]Associate Professor, Department of Orthopaedics, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India.*
*[3]Professor, Department of Orthopaedics, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India.*
*[4]Associate Professor, Department of Anatomy, Rohilkhand Medical College, Bareilly, Uttar Pradesh, India.*
*[5]Professor & HOD, Department of Orthopaedics, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India.*
*[6]Assistant Professor, Department of Orthopaedics, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India.*

***Received*** *: 02/09/2024*
***Received in revised form*** *: 20/10/2024*
***Accepted*** *: 05/11/2024*

**Corresponding Author:**
**Dr. Vidit Sonakia,**
Junior Resident (3rd year), Department of Orthopaedics, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India.
Email: vidit07sonakia@gmail.com

**DOI:** 10.70034/ijmedph.2024.4.97

**Source of Support:** Nil,
**Conflict of Interest:** None declared

**Int J Med Pub Health**
2024; 14 (4); 512-519

## ABSTRACT

**Background:** Cervical spondylodiscitis is a rare but potentially life-threatening infection characterized by inflammation of the vertebrae and discs, leading to significant morbidity and neurological complications. The aim of this study was to evaluate the outcomes of surgical intervention in patients with cervical spondylodiscitis, focusing on improvements in pain and neurological status.

**Material and Methods:** A retrospective randomized controlled study was conducted in the Department of Orthopaedics at Rajshree Medical Research Institute, Bareilly (U.P) including 30 patients who underwent anterior surgical intervention between June 2022 and September 2023. Inclusion criteria encompassed patients with cervical spondylodiscitis presenting with neurological deficits, spinal instability, or myelopathy. Preoperative and postoperative assessments utilized the Visual Analogue Scale (VAS), the Modified McCormick Scale, and radiological evaluations. Statistical analyses were performed using SPSS software.

**Results:** The cohort comprised 60% females and 40% males, with a mean age of 50 years. Postoperative evaluations indicated significant improvements, with mean VAS scores decreasing from 8.29 at presentation to 1 at 3, 6, and 12 months ($p < 0.001$). The Modified McCormick Scale also demonstrated significant postoperative improvement. Ten patients required re-exploration due to complications, primarily in those with comorbidities such as diabetes and chronic kidney disease, but subsequently showed marked improvements in pain scores.

**Conclusion:** Surgical intervention for cervical spondylodiscitis significantly enhances patient outcomes, as reflected in reduced pain and improved neurological function. This study highlights the necessity for timely surgical intervention and careful management of comorbid conditions to optimize recovery and reduce complications, advocating for proactive strategies in treating infectious spondylodiscitis.

**Keywords:** Cervical spondylodiscitis, surgical intervention, Visual Analogue Scale (VAS), neurological outcomes, Modified McCormick Scale, morbidity.

## INTRODUCTION

Cervical spondylodiscitis is an uncommon infectious ailment that affects the axial skeleton, posing a dual threat to patients both locally and systemically. Local threats include severe structural damage leading to associated neurological deficits, while systemic manifestations result in a debilitating

systemic disease. The occurrence of spondylodiscitis within spinal segments typically follows a descending order, affecting the lumbar, thoracic, and cervical spine sequentially. The likelihood of epidural abscesses or neurological complications increases in the same order cervical spine been the one with most complications.[1]

Notably, existing literature on spondylodiscitis predominantly documents a limited number of cases involving the cervical spine. However, when infection occurs in this region, the unique anatomical features of the cervical spine, including its vascular and lymphatic connections and their proximity to critical anatomical structures, render it particularly vulnerable to serious complications.[2]

Cervical spondylodiscitis is a potentially life-threatening infection associated with a high morbidity rate. Although vertebral osteomyelitis is relatively rare, occurring at a rate of 3-5%, it stands as the third most common form of osteomyelitis among individuals over 50 years of age.[3-6] Spondylodiscitis, characterized by infectious inflammation affecting the vertebrae, vertebral discs, and adjacent structures, can be induced by a range of bacterial pathogens. Staphylococcus aureus is the predominant causative agent in the majority of spondylodiscitis cases.[7-10]

Despite its rarity, the incidence of spondylodiscitis has been on the rise, with an average of seven cases per million, affecting men three times more frequently than women.[11] Factors contributing to this increase include the widespread use of immunosuppressive drugs and an aging population.[12,13] While spondylodiscitis is most commonly observed in the sixth decade of life, it can occur at any age.[14] Risk factors encompass conditions such as diabetes mellitus, malnutrition, steroid therapy, rheumatic diseases, and a history of spinal surgery.[15-17]

Surgical intervention is recommended based on patient-specific factors, including pain, neurological deficits, sepsis, compressive myelopathy, spinal cord compression, and spinal instability.[18-20]

Given the limited number of studies analyzing outcomes in this area, we conducted an evaluation at our institution of patients undergoing anterior approach surgery for the management of cervical spondylodiscitis. The primary objective of our study was to assess improvements in neurological status following surgery. This evaluation was based on key parameters, including pain severity, measured through the Visual Analogue Scale (VAS); the time required for patients to resume work, recorded in days; and the Modified McCormick scale, used to quantify neurological deficits. By examining these indicators, we aimed to provide a thorough assessment of both physical and functional recovery, contributing valuable insights into the effectiveness of the anterior surgical approach for managing cervical spondylodiscitis.

## MATERIALS AND METHODS

Following approval from the institutional ethics committee, this retrospective randomized controlled study was conducted in the Department of Orthopaedics at Rajshree Medical Research Institute in Bareilly (U.P). We included 30 patients who underwent surgery between June 2022 and September 2023, encompassing cases both with and without neurological deficits that met the inclusion criteria. Written informed consent was obtained from all participants after a thorough explanation of the study protocol.

**Inclusion Criteria**

- All patients with cervical spondylodiscitis with spinal instability, neurological deficit, spinal cord compression, cord myelopathy was included.

**Exclusion Criteria**

- Non consenting patients;
- Patients with multiple co-morbidities which were unfit for the surgery; and
- Patients with previous instrumented fixation, non- bacterial infections such as fungal infections were excluded.

**Methodology**

All 30 patients operated in our institution by a single surgeon during the period of study were included. The rationale for surgery was predominantly based on neurological deficits (myelopathy, radiculopathy), intractable neck or arm pain, and elevated or rising inflammation markers under antibiotic treatment. The surgical approach and implants were based on the surgeons' preferences. Patient evaluation was done accordingly based on clinical presentation, neurological status, radiological studies and laboratory analysis. X-rays, MRI were main radiological tools prior and post-surgery. Pre-op and post-op assessment scores was based on ODI and VAS and modified McCormick scale.

**Postoperative Evaluation**

Postoperatively, each patient's neurological status was immediately assessed. Samples for culture sensitivity, tissue biopsy, Gram staining, and CBNAAT were taken to monitor infection. Key blood markers—Total Leukocyte Count (TLC) and C-reactive Protein (CRP)—were tracked postoperatively. Culture and Gram stain reports, available by the third postoperative day, guided antibiotic therapy, which was administered for approximately three months. If GeneXpert testing indicated tuberculosis, antitubercular treatment was given for at least 12 months.

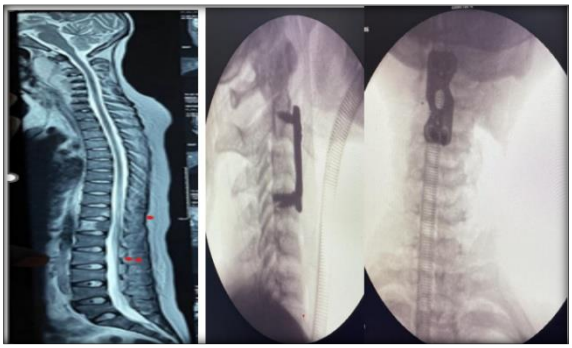
Broad-spectrum IV antibiotics (vancomycin, linezolid, and levofloxacin) were initially administered, then transitioned to oral forms based on clinical and hematological parameters. Pain management included paracetamol, and a postoperative drain was monitored daily, typically removed between days 5 and 9. Mobilization began

on day 0, with walking from day 1, alongside multivitamins, vitamin D3, and physiotherapy. Infection resolution was assessed through radiological, clinical, and lab evaluations, with pain and neurological status evaluated at 3, 6, and 12 months. Instrumented fixation with pedicle screws, rods, spinal cages, and bone grafts was tailored to each patient. MRI was performed at 9 months or as indicated by neurological changes, and periodic X-rays were conducted.

**Statistical Analysis**

Descriptive statistics were conducted using SPSS Statistics (version 26.0, IBM Corp, Armonk, NY, USA). Data are presented as frequencies, percentages and mean with standard deviation (SD) and confidence interval (CI). Significant associations were identified using Chi-square and ANOVA test. A p-value of ≤0.05 was considered statistically significant.

**Preoperative X ray and MRI**

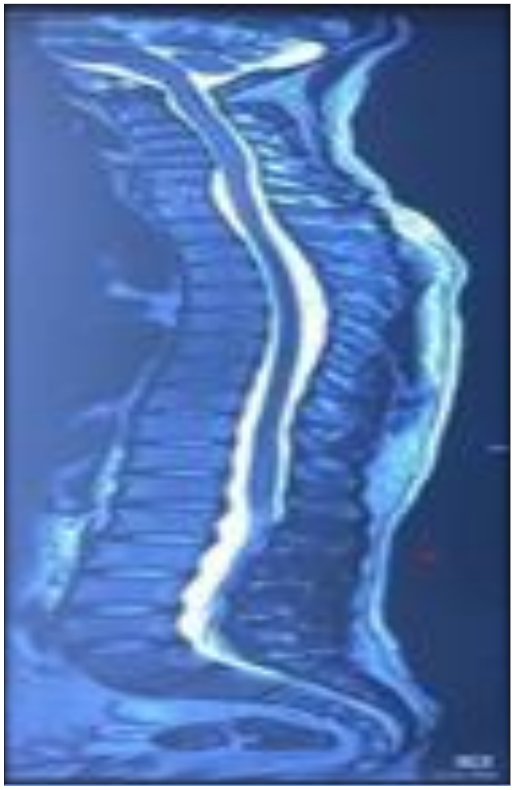


**Intra operative X ray**

**Surgical Procedure**

**Postoperative X ray**

**Figure 1: Case 1: C2-C3.C3-C4.C4-C5 spondylodiscitis with compressive myelopathy with quadriparesis**



**Pre-operative MRI**

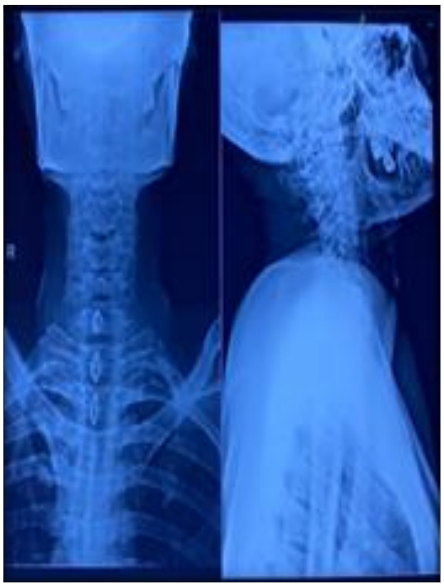
Post-operative X ray

**Figure 2: Case 2: C5-C6 cervical spondylodiscitis with compressive myelopathy**

**Post-operative X ray**

**Figure 3: Case 3: C2-C3 spondylodiscitis with quadriparesis**

**Pre-operative X ray**



**Pre-operative MRI**

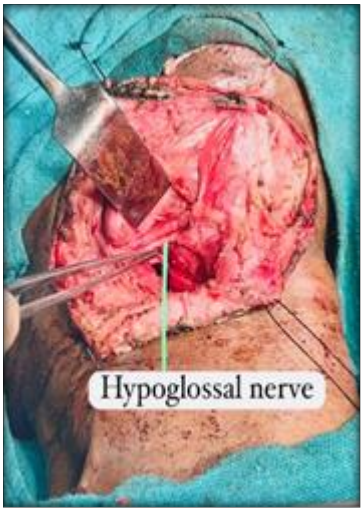



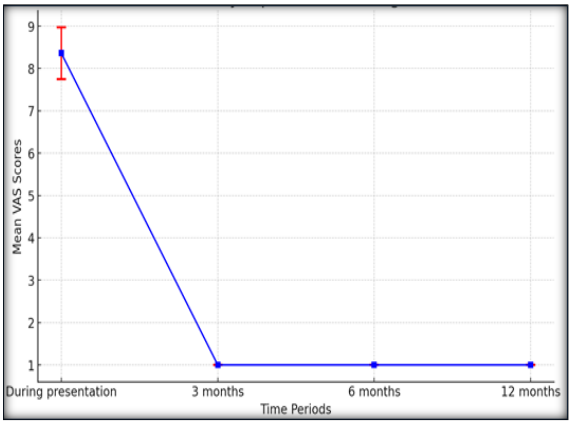
**Figure 4: Surgical procedure followed by implant placement**

## RESULTS

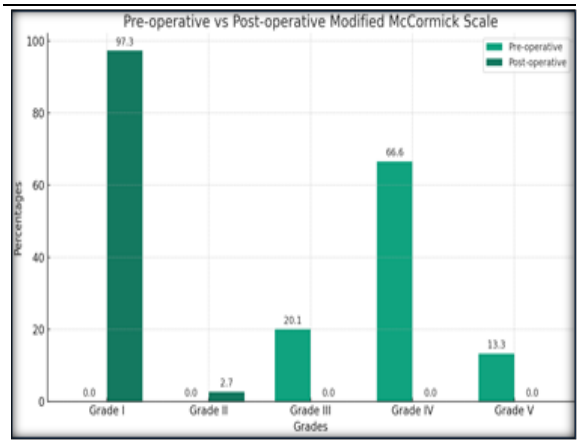
In this study, we included 30 patients, comprising 18 (60%) females and 12 (40%) males. The study population consisted of 10 patients aged 17 to 40 years, while 20 patients were over 40 years old, resulting in 22.5% being in the 17-40 age group and 77.5% being older than 40 years. [Table 1]

The mean total leukocyte count was 13,650.0 per microlitre, which decreased significantly after three months of treatment. The mean C-reactive protein (CRP) level was 25.53 mg/dl, which also showed a significant decrease. [Table 2]

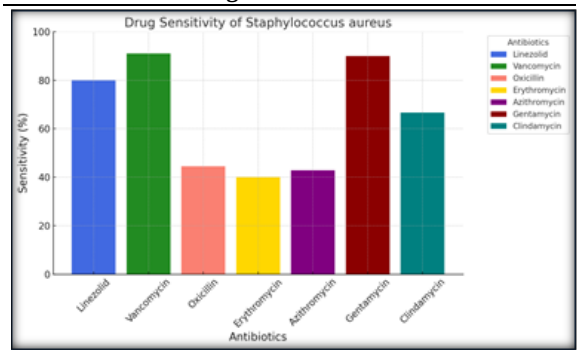
We used different scoring systems to know outcome. The mean Visual Analogue Scale (VAS) score was analyzed using repeated measures ANOVA, followed by the post-hoc Bonferroni test. The results demonstrated a significant decrease in the mean VAS score from the time of presentation to the 3, 6, and 12-month follow-ups. The mean VAS score at presentation was 8.29, with a standard deviation of 0.61, while the mean VAS scores at 3, 6, and 12 months were all recorded as 1, with a p-value of < 0.001. Additionally, the decrease in VAS scores from presentation to 3 months and subsequently to 6 and 12 months was highly significant, with a p-value of 0.000. The outcomes for patients operated on by our surgeon were promising, with 95% of cases showing improvement in their postoperative follow-up. [Table 3] Conversely, Modified McCormik grade improved significantly postoperatively. [Table 4, Graph 2]



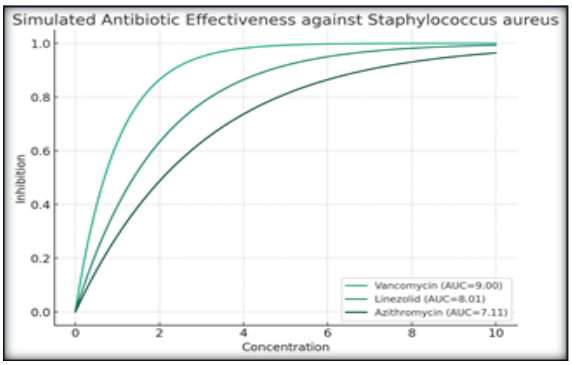

**Graph 1: Comparison of Preoperative and Postoperative (3,6 and 12 months) Mean Values of VAS**




**Graph 2: Comparison of Preoperative and Postoperative (3,6 and 12 months) Mean Values of Modified McCormik grade**




**Graph 3: Distribution of study participants according to Drug sensitivity of Staphylococcus aureus**




**Graph 4: Simulated Antibiotic effectiveness against Staphylococcus aureus**

The distribution of the study population undergoing debridement based on Visual Analog Scale (VAS) scores at different time intervals i.e., at 3 months, 6 months, and 12 months post-debridement showed an insignificant decrease in VAS score from 3 months to 12 months (P>0.05).

Complication: Out of the 30 patients in our study, 10 required re-exploration of the surgical wound for debridement. This decision was based on indicators such as persistent fever, continuous copious discharge from the surgical site, excessive drain output, and ongoing elevation of inflammatory markers, particularly CRP. Notably, all patients who underwent re-exploration had multiple comorbidities, including Diabetes Mellitus, Chronic Renal Failure, Chronic Obstructive Pulmonary Disease (COPD), and Hypertension. Following the second surgical intervention, the postoperative VAS scores of these patients showed significant improvement.

**Table 1: Distribution of study population according to demographic parameters**

| Parameters | Frequency (N=30) | Percent (%) |
|---|---|---|
| **Age in years** | | |
| 17-40 years | 10 | 22.5% |
| > 40 years | 20 | 77.5% |
| **Gender** | | |
| Female | 18 | 60.0% |
| Male | 12 | 40.0% |

**Table 2: Comparison of Preoperative and Postoperative Mean Values of TLC and CRP**

| | Mean | Std. Deviation | Minimum | Maximum | p-value |
|---|---|---|---|---|---|
| **TLC (cells/ microlitre)** | | | | | |
| Baseline | 13650.00 | 4197.91 | 10200.00 | 30000.00 | 0.027* |
| At 3 months | 5695.00 | 972.37 | 4500.00 | 8500.00 | |
| **CRP** | | | | | |
| Baseline | 25.57 | 7.11 | 12.00 | 45.00 | 0.015* |
| At 3 months | 1.57 | 0.92 | 0.30 | 4.00 | |

**Table 3: Comparison of Preoperative and Postoperative (3,6 and 12 months) Mean Values of VAS**

| VAS score | Mean | Std. Deviation | p-value | post-hoc comparisons |
|---|---|---|---|---|
| During presentation | 8.36 | 0.61 | 0.001 | During presentation > 3, 6 & 12 Months |
| 3 months | 1.00 | 0.00 | | |
| 6 months | 1.00 | 0.00 | | |
| 12 months | 1.00 | 0.00 | | |

**Table 4: Modified McCormik scale**

| Modified McCormik scale | Pre-operative | | Post-operative | |
|---|---|---|---|---|
| | N | % | N | % |
| Grade I | 0 | 0.0% | 14 | 97.3% |
| Grade II | 0 | 0.0% | 1 | 2.7% |
| Grade III | 3 | 20.1% | 0 | 0.0% |
| Grade IV | 10 | 66.6% | 0 | 0.0% |
| Grade V | 2 | 13.3% | 0 | 0.0% |
| p-value | 0.001* | | | |

**Table 5: Mean Values of VAS in patients with debridement at different postoperative durations (3,6 and 12 months)**

| VAS score | Mean | Std. Deviation | p-value |
|---|---|---|---|
| 3 months | 1.26 | 0.00 | 0.06 |
| 6 months | 1.00 | 0.00 | |
| 12 months | 1.00 | 0.00 | |

## DISCUSSION

We conducted a retrospective review of the clinical and radiological parameters of patients treated for primary cervical spondylodiscitis over one-year period at a single tertiary care center. Cervical spondylodiscitis has historically been recognized as a rare condition, diagnosed in only 9% of patient population.[21] However, advancements in imaging diagnostics and an aging population may contribute to an increasing prevalence of this spine infection overall.[22]

The clinical characteristics of the patient cohort in our study aligned with findings from prior meta-analyses and retrospective case series.[22-24] Our study included 30 patients with a mean age of 52.0 years, of which 22.5% were under 40 years old and 77.5% were over 40. The majority of our patients were female, accounting for 60%, compared to 40% male patients. The mean total leukocyte count was 13,650.0 per microlitre while the mean C-reactive protein (CRP) level was 25.53 mg/dl.

In comparison, the study by Homagk et al,[8] included 296 patients with a mean age of 67.3 years,

where 66.2% were aged between 60 to 80 years, and 56.7% were male, while 40% were female. Additionally, Tsai et al,[9] conducted a similar study that included two groups: Group 1, consisting of 26 patients treated only with antibiotics, had a mean age of 62, with 68.2% male and 30.8% female; and Group 2, with 35 patients undergoing both surgical and antibiotic treatment, had a mean age of 58.4 years, where males constituted 74.3% and females 25.7%. The mean CRP in Tsai et al.'s study was reported as 28.3 mg/dl.

Homagk et al,[8] utilized C-reactive protein (CRP) and total leukocyte count (TLC) as laboratory markers for patient evaluation post-surgery, similar to our study. In their study, the mean CRP at admission was 119.9 mg/dl, which decreased to 43 mg/dl at the time of discharge after one month. In contrast, our study recorded a mean CRP level of 25.7 mg/dl during presentation, which significantly reduced to a mean of 1.48 mg/dl after three months, with a p-value of 0.015, compared to their <0.05.

Regarding TLC, Homagk et al,[8] reported a mean value of 10.6 with a p-value of <0.05 at presentation, while our study had a mean TLC of 13.4 and a p-value of 0.027 ($p < 0.05$). They observed that TLC levels generally fell to the normal value of 9.5 at discharge, whereas in our study, the mean TLC was measured at 5.7 after three months, also with a p-value of 0.027 ($p < 0.05$).

Tsai et al,[9] assessed the performance outcomes of surgically treated patients using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI), similar to our approach. They reported mean values of 1.4 for VAS and 8.8 for ODI with p-values of 0.034 and 0.048, respectively. In comparison, our study followed up regularly at 3, 6, 12, and 24 months, yielding mean scores of 1 for VAS and 5 for ODI, with a p-value of 0.000 ($p < 0.05$).

These results align with findings from Raj et al,[11] who noted that patients receiving appropriate treatment for infectious spondylodiscitis generally report high satisfaction levels concerning their quality of life. However, the likelihood of recurrence increases in the presence of conditions such as diabetes mellitus and renal failure. Effective management of these cases often involves prompt debridement, resulting in positive outcomes, with assessment conducted through the postoperative ODI and VAS, as highlighted in their study.[11]

This study's limitations include a small sample size and its single-center design, which may restrict the generalizability of the findings. Additionally, the short duration of follow-up may not adequately capture long-term outcomes associated with surgical intervention for cervical spondylodiscitis. Further studies are needed to validate these findings through larger, multi-center trials that encompass a more diverse patient population. Additionally, longer follow-up periods are essential to thoroughly evaluate the long-term outcomes and potential complications associated with surgical interventions for cervical spondylodiscitis.

## CONCLUSION

In conclusion, our investigation involving 30 patients demonstrated that appropriate surgical intervention for infectious spondylodiscitis leads to significant improvements in patient outcomes, as evidenced by substantial reductions in Visual Analog Scale (VAS) scores and favorable neurological assessments over one year. The statistically significant p-values (0.001) for both VAS and McCormick scale outcomes reinforce the effectiveness of the treatment provided. Additionally, the study identified a heightened risk of recurrence associated with comorbidities, particularly diabetes mellitus, necessitating prompt surgical re-intervention in these cases.

Our findings underscore the critical importance of early surgical intervention to enhance patient recovery, promote timely mobilization, and reduce the risk of spinal cord injury. Overall, the results of this study advocate for a proactive approach in managing infectious spondylodiscitis, ensuring optimal patient outcomes and improved quality of life.

## REFERENCES


1. M. Kehrer, C. Pedersen, T.G. Jensen, A.T. Lassen, increasing incidence of pyogenic spondylodiscitis: a 14-year population-based study, J. Infect. 68 (4) (2014) 313–320, https://doi.org/10.1016/j.jinf.2013.11.011.
2. A. Sur, K. Tsang, M. Brown, N. Tzerakis, Management of adult spontaneous spondylodiscitis and its rising incidence, Ann. R. Coll. Surg. Engl. 97 (6) (2015) 451–455, https://doi.org/10.1308/rcsann.2015.0009.
3. K. Issa, B.G. Diebo, M. Faloon, et al., The epidemiology of vertebral osteomyelitis in the United States from 1998 to 2013, Clin. Spine Surg. 31 (2) (2018) E102–E108, https://doi.org/10.1097/BSD.0000000000000597.
4. D.G. Taylor, A.L. Buchholz, D.R. Sure, et al., Presentation and outcomes after medical and surgical treatment versus medical treatment alone of spontaneous infectious spondylodiscitis: a systematic literature review and meta-analysis, Global Spine J. 8 (4 Suppl) (2018) 49S–58S, https://doi.org/10.1177/ 2192568218799058.
5. N.R. Sproston, J.J. Ashworth, Role of C-reactive protein at sites of inflammation and infection, Front. Immunol. 9 (2018) 754, https://doi.org/10.3389/ fimmu.2018.00754.
6. G.J. Przybylski, A.D. Sharan, Single-stage autogenous bone grafting and internal fixation in the surgical management of pyogenic discitis and vertebral osteomyelitis, J. Neurosurg. 94 (1 Suppl) (2001) 1–7, https://doi.org/10.3171/spi.2001.94.1.0001.
7. P.C.Hsieh,R.J.Wienecke,B.A.OShaughnessy,T.R.Koski,S.L.Ondra,Surgicalstrategiesforvertebralosteomyelitisandepiduralabscess,Neurosurg.Focus17 (6) (2004) E4, https://doi.org/10.3171/foc.2004.17.6.4.
8. B.U. Homagk S.H. Lee, Y. Ahn, W.C. Choi, Y.G. Choi, Surgical site infection in spinal surgery: detection and management based on serial C-reactive protein measurements, J. Neurosurg. Spine 13 (2) (2010) 158–164, https://doi.org/10.3171/2010.3.SPINE09403.
9. I. Tsai, A. Padoan, D. Bozzato, M. Plebani, Erythrocyte sedimentation rate and C-reactive protein in acute inflammation, Am. J. Clin. Pathol. 153 (1) (2020) 14–29, https://doi.org/10.1093/ajcp/aqz142.
10. G.Stoop,M.A.R.Soliman,A.M.Ali,M.H.Aly,Spontaneousspondylodiscitis:review,incidence,management,andclinicaloutc

omein44patients,Neurosurg. Focus 46 (1) (2019) E10, https://doi.org/10.3171/2018.10.FOCUS18463.
11. Raj S, Lal V, Tuli AK, Tiwari G, Saxena D, Mughal N, Shrivastav AK, Verma V. Management and outcome of infectious spondylodiscitis in patients with and without neurological deficit: A prospective study. J Orthop Trauma Surg Rel Res. 2023;18(2):1-6.
12. D.K.Jeong,H.W.Lee. Clinical value of procalcitonin in patients with spinal infection, J. Korean Neurosurg.Soc.58(3) (2015);271- 275, https://doi.org/10.3340/jkns.2015.58.3.271.
13. Acosta F.L. Jr., Chin C.T., Quinones-Hinojosa A., Ames C.P., Weinstein P.R., Chou D. Diagnosis and management of adult pyogenic osteomyelitis of the cervical spine. Neurosurg Focus. 2004;17(6) doi:10.3171/foc.2004.17.6.2.
14. Gouliouris T., Aliyu S.H., Brown N.M. Spondylodiscitis: update on diagnosis and management. J Antimicrob Chemother. 2010;65(Suppl 3) doi:10.1093/jac/dkq303.
15. Modic M.T., Feiglin D.H., Piraino D.W., et al. Vertebral osteomyelitis: assessment using MR. Radiology. 1985;157(1):157-166. doi:10.1148/radiology.157.1.3875878
16. Arbelaez A., Restrepo F., Castillo M. Spinal infections: clinical and imaging features. Top Magn Reson Imag. 2014;23(5):303-314. doi:10.1097/RMR.0000000000000032.
17. Post M.J., Sze G., Quencer R.M., Eismont F.J., Green B.A., Gahbauer H. Gadolinium-enhanced MR in spinal infection. J Comput Assist Tomogr. 1990;14(5):721-729. doi:10.1097/00004728-199009000-00008.
18. Leone A., Dell'Atti C., Magarelli N., et al. Imaging of spondylodiscitis. Eur Rev Med Pharmacol Sci. 2012;16(Suppl 2):8-19.
19. Talbott J.F., Shah V.N., Uzelac A., et al. Imaging-based approach to extradural infections of the spine. Semin Ultrasound CT MR. 2018;39(6):570-586. doi: 10.1053/j.sult.2018.09.003.
20. Love C., Patel M., Lonner B.S., Tomas M.B., Palestro C.J. Diagnosing spinal osteomyelitis: a comparison of bone and Ga-67 scintigraphy and magnetic resonance imaging. Clin Nucl Med. 2000;25(12):963-977. doi:10.1097/00003072-200012000-00002.
21. Motov S., Stemmer B., Krauss P., Bonk M.N., Wolfert C., Steininger K., Shiban E., Sommer B. Clinical and surgical outcome in patients with cervical spondylodiscitis: a single-center retrospective case series of 24 patients. Front Surg. 2024; 11:1292977. doi:10.3389/fsurg.2024.1292977.
22. Stangenberg M., Mohme M., Mende K.C., Thiesen D.M., Kratzig T., Schoof B., et al. Impact of localization on disease course and clinical management in spondylodiscitis. Int J Infect Dis. 2020; 99:122-130. doi: 10.1016/j.ijid.2020.07.028.
23. Barnes B., Alexander J.T., Branch C.L. Jr. Cervical osteomyelitis: a brief review. Neurosurg Focus. 2004;17(6). doi:10.3171/foc.2004.17.6.11.
24. Burkhardt B.W., Muller S.J., Wagner A.C., Oertel J.M. Anterior cervical spine surgery for the treatment of subaxial cervical spondylodiscitis: a report of 30 consecutive patients. Neurosurg Focus. 2019;46(1). doi:10.3171/2018.10. FOCUS18464.