



LONG-TERM OUTCOMES AND SURGICAL MANAGEMENT OF CONJOINED LUMBOSACRAL NERVE ROOTS: A CASE SERIES AND LITERATURE REVIEW

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ABSTRACT

Objectives: Conjoined lumbosacral nerve roots (CNR) are rare congenital anomalies that can complicate the diagnosis and management of lumbar radiculopathy. These anatomical variants, frequently located at the L5–S1 level, are often underdiagnosed due to atypical imaging appearances and non-specific symptoms. Surgical treatment, especially in cases associated with degenerative spine disease, poses unique challenges. This study aims to present a retrospective case series evaluating long-term clinical and radiological outcomes following various surgical interventions for CNR, including transforaminal lumbar interbody fusion (TLIF), laminectomy, microdiscectomy, and endoscopic discectomy. **Case Report:** Ten patients (6 females, 4 males; mean age 42.1 years) with MRI- or CT-confirmed CNR underwent surgical treatment at a tertiary care spine center between 2017 and 2023. All patients presented with radiculopathy, and the majority had motor deficits or chronic low back pain. Surgical intervention was performed after the failure of conservative management. TLIF was performed in six patients, laminectomy (with or without discectomy) in three, and endoscopic discectomy in one. Outcomes were assessed using the Visual Analog Scale (VAS) for pain, Medical Research Council (MRC) grading for motor strength, imaging for decompression/fusion, and complication and recurrence rates. At one-year follow-up, 80% of patients achieved $\geq 50\%$ symptom relief. Postoperative complications occurred in 30% of cases, including nerve root irritation and hardware migration. Recurrence of symptoms was observed in 3 patients (30%), one of whom required revision surgery. Radiological follow-up confirmed effective neural decompression in 70% and successful fusion in 83% of TLIF patients. **Discussion:** This case series demonstrates that surgical intervention, particularly TLIF, provides significant and sustained symptomatic improvement in patients with symptomatic CNR. TLIF was especially effective in patients with concurrent spinal instability or foraminal stenosis, offering both decompression and long-term mechanical stability. The importance of preoperative diagnosis using advanced imaging, including oblique MRI and CT myelography, is emphasized for surgical planning and avoidance of intraoperative complications. While minimally invasive techniques like endoscopic discectomy showed promise, their use remains limited and warrants further investigation. Symptom recurrence was primarily attributed to adjacent segment degeneration and hardware-related complications, highlighting the need for long-term follow-up and individualized postoperative care. These findings support the integration of tailored surgical strategies in the management of CNR and call for further prospective studies to optimize treatment protocols.

KEYWORDS : Conjoined nerve roots, TLIF, laminectomy, lumbar radiculopathy, minimally invasive spine surgery, foraminal stenosis

INTRODUCTION:

Conjoined lumbosacral nerve roots (CNR) are a rare congenital anomaly characterized by the fusion or abnormal course of two adjacent nerve roots, most frequently at the L5–S1 level. These anatomical variants typically arise from disturbances during embryological development, resulting in nerve roots exiting through a common dural sheath or foramen. Though often asymptomatic, CNR may present clinically with chronic low back pain, radiculopathy, sensory deficits, and motor weakness, especially when associated with degenerative spinal conditions such as disc herniation or

spondylolisthesis [1,2]. The prevalence of CNR is estimated to be between 2% and 17% in the general population based on imaging and cadaveric studies [2]. Clinically, the condition may be underdiagnosed due to its subtle radiological features and its capacity to mimic more common spinal pathologies like isolated disc prolapse, foraminal stenosis, or cauda equina syndrome [1,3]. In many cases, patients may undergo extensive conservative treatments or inappropriate interventions before the correct diagnosis is made.

Standard MRI may fail to detect conjoined roots due to their

variable morphology and orientation. Advanced imaging techniques such as oblique MRI sequences, MR neurography, and CT myelography have been shown to improve diagnostic accuracy [3,4]. Accurate diagnosis is critical because the presence of CNR alters the surgical anatomy and significantly influences surgical planning and technique. Unrecognized CNR during decompression or discectomy may result in iatrogenic nerve injury or inadequate decompression, leading to poor clinical outcomes [5]. While conservative management (physical therapy, medications, nerve blocks) may be initially attempted in mild cases, surgery is often required in symptomatic patients with persistent or progressive neurological deficits [6]. Surgical strategies typically involve decompression (laminectomy or discectomy) and, when instability is present, fusion techniques such as transforaminal lumbar interbody fusion (TLIF) [7,8]. However, due to the anomalous nerve course and associated foraminal or central stenosis, surgery in patients with CNR is technically demanding and carries increased risk of complications such as nerve root irritation, residual symptoms, and hardware failure [7,9]. Although case reports and small series have described CNR, there is limited literature focusing on the long-term outcomes of surgical interventions in these patients [2,5,7]. Furthermore, the recurrence of symptoms postoperatively, particularly due to degeneration or foraminal stenosis, remains a major clinical concern. There is a pressing need for more extensive clinical evidence to guide optimal treatment strategies.

This study presents a comprehensive retrospective case series of patients with diagnosed CNR who underwent surgical management. The primary objective is to evaluate long-term outcomes, including pain relief, motor recovery, recurrence, and complication rates, following procedures such as TLIF and laminectomy. By analyzing a diverse cohort with variable presentations and follow-up durations, we aim to contribute valuable clinical data and surgical insights to the evolving understanding of this challenging spinal pathology.

Case Presentation:

This retrospective case series includes 10 patients with radiologically confirmed conjoined lumbosacral nerve roots (CNR) who underwent surgical management at Vydehi Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India between 2017 and 2023. All patients presented with persistent or progressive symptoms despite conservative management, including pharmacologic therapy, physical rehabilitation, and epidural steroid injections. Diagnosis of CNR was established using advanced imaging modalities, including MRI with oblique sequences and CT myelography, as these techniques have shown superior sensitivity in identifying anomalous nerve root trajectories [3,4]. The cohort consisted of 6 female and 4 male patients, with a mean age of 42.1 years (range: 28–60). Symptom duration prior to surgical intervention ranged from 9 to 24 months (mean: 14.7 months). The most common presenting complaint was unilateral or bilateral radicular leg pain (100%), followed by motor weakness (70%) and low back pain (60%). All patients had failed at least 3 months of non-operative treatment (Table 1).

MRI revealed various associated pathologies, including foraminal stenosis (60%), lumbar disc herniation (40%), and spondylolisthesis (30%), consistent with prior studies highlighting the common co-existence of CNR with degenerative spinal conditions [1,2,5]. The most frequently involved levels were L4–L5 and L5–S1, in accordance with the distribution reported in anatomical and surgical literature [1,4]. Surgical procedures were determined based on imaging findings, degree of instability, and patient-specific factors. Six patients underwent transforaminal lumbar interbody fusion (TLIF), three underwent laminectomy with or without microdiscectomy, and one patient underwent endoscopic

discectomy. The choice of TLIF was preferred in patients with segmental instability or recurrent foraminal narrowing, aligning with current recommendations for providing both decompression and stabilization [6,7]. A detailed visual representation of a case from the study is included as below [Figure 1-4].

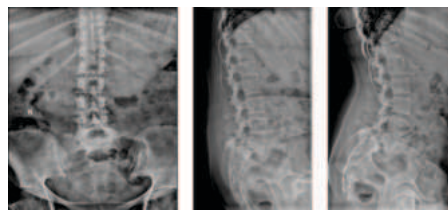


Figure 1: Pre-Operative X-ray of LS Spine AP view, Lateral view in flexion and extension

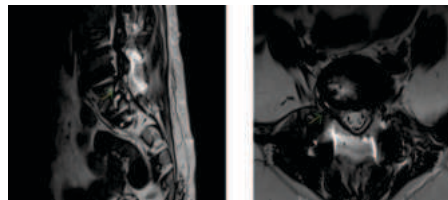


Figure 2: MRI showing the Conjoined nerve root: Sagittal and Axial section



Figure 3: Intra operative picture showing the Conjoined Nerve Root

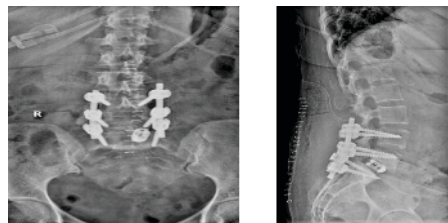


Figure 4: Post-operative X-ray of LS Spine: AP and Lateral view

At 1-year follow-up, 8 out of 10 patients (80%) reported $\geq 50\%$ reduction in pain scores (VAS) and improvement in motor strength by at least one MRC grade. Patients who underwent TLIF had more durable relief and lower recurrence rates. Radiological evaluation showed solid interbody fusion in 5 of the 6 TLIF patients (83%) and satisfactory decompression in 7 of 10 patients overall (Table 2). Three patients (30%) experienced recurrence of symptoms. In Case 4, hardware migration and restenosis necessitated revision surgery. The remaining two patients were managed non-operatively. These recurrence rates are consistent with reports by Takagi et al. and Basani et al., who noted similar outcomes in long-term follow-ups of patients undergoing lumbar fusion for complex nerve root anomalies [1,9]. Complications occurred in 3 patients (30%). These included transient nerve root irritation in two cases and superficial surgical site infection in one case, all managed successfully with conservative measures. No permanent neurological deficits were observed. The complication profile was in line with data from prior studies on TLIF in anatomically complex lumbar cases [7,9].

Table 1. Patient Demographics and Clinical Presentation

Patient No.	Age	Sex	Duration of Symptoms (months)	Radiculopathy	Motor Deficit	Low Back Pain	Imaging Findings
1	34	M	12	Yes	Yes	Yes	CNR at L5-S1, Disc herniation
2	49	F	18	Yes	No	Yes	CNR at L4-L5, Foraminal stenosis
3	39	F	10	Yes	Yes	No	CNR at L5-S1, Spondylolisthesis
4	60	F	24	Yes	Yes	Yes	CNR at L4-L5, Foraminal stenosis, Disc herniation
5	41	M	15	Yes	No	No	CNR at L5-S1, Foraminal stenosis
6	28	F	9	Yes	Yes	Yes	CNR at L5-S1, Disc herniation
7	45	F	14	Yes	Yes	No	CNR at L4-L5, Spondylolisthesis
8	38	M	16	Yes	No	Yes	CNR at L4-L5, Foraminal stenosis
9	55	F	20	Yes	Yes	Yes	CNR at L5-S1, Disc herniation
10	47	F	13	Yes	Yes	Yes	CNR at L5-S1, Foraminal stenosis

Table 2. Surgical Management, Outcomes, and Complications

Patient No.	Procedure	Level	VAS (Pre → Post)	Motor Recovery	Fusion Achieved	Complications	Recurrence	Reoperation
1	TLIF	L5-S1	8 → 1	Yes	Yes	None	No	No
2	Laminectomy	L4-L5	7 → 3	No	N/A	None	Yes	No
3	TLIF	L5-S1	8 → 2	Yes	Yes	Nerve root irritation	No	No
4	TLIF	L4-L5	9 → 4	Yes	No	Hardware migration	Yes	Yes
5	Laminectomy	L5-S1	6 → 2	N/A	N/A	Superficial infection	No	No
6	TLIF	L5-S1	8 → 1	Yes	Yes	None	No	No
7	TLIF	L4-L5	7 → 3	Yes	Yes	None	No	No
8	TLIF	L4-L5	7 → 3	N/A	Yes	Nerve root irritation	No	No
9	Endoscopic discectomy	L5-S1	7 → 2	Yes	N/A	None	No	No
10	Laminectomy	L5-S1	8 → 5	Yes	N/A	None	Yes	No

DISCUSSION:

Conjoined lumbosacral nerve roots (CNR) present a complex surgical challenge due to their rarity, variable anatomical presentations, and frequent association with degenerative lumbar spine disease. This case series highlights the diagnostic intricacies, procedural strategies, and long-term outcomes associated with surgical management of CNR,

specifically using transforaminal lumbar interbody fusion (TLIF), laminectomy, and minimally invasive endoscopic techniques. CNR may present with symptoms mimicking common spinal conditions such as disc herniation or foraminal stenosis, leading to misdiagnosis and failed interventions [1,2]. In our series, several patients had undergone prolonged conservative management before CNR was identified using advanced imaging modalities. Conventional MRI, particularly in the axial and sagittal planes, often fails to detect the anomalous trajectory of nerve roots. In contrast, oblique MRI and CT myelography significantly improved visualization, corroborating findings by Engar et al. and Akhaddar [3,4]. The delay in diagnosis underscores the need for heightened clinical suspicion and the routine use of dedicated imaging in atypical or refractory radiculopathy.

Surgical intervention, particularly TLIF, resulted in substantial clinical improvement in this series. Eight of ten patients (80%) reported ≥50% symptom relief, and motor recovery was achieved in all but one case. TLIF was associated with superior long-term results, consistent with prior studies by Bydon et al. and Tabarestani et al., which emphasized the dual benefit of decompression and stabilization in anatomically complex scenarios [6,7]. This is particularly important in CNR cases complicated by spondylolisthesis or severe foraminal stenosis, where simple decompression may not be sufficient. Patients who underwent laminectomy or microdiscectomy without fusion showed good initial outcomes but had a higher tendency toward symptom recurrence, particularly in the presence of underlying segmental instability. These findings align with Franco et al., who reported better long-term outcomes in patients managed with combined decompression and fusion [5].

Three patients (30%) experienced recurrence of symptoms during long-term follow-up, which is consistent with published recurrence rates for lumbar decompression procedures [1,9]. In one case, hardware migration necessitated revision surgery—likely a consequence of suboptimal screw placement or poor compliance with postoperative restrictions. This supports the conclusions by Basani et al. regarding the technical demands and potential complications of TLIF in distorted spinal anatomy [9]. Minor complications such as transient nerve root irritation and superficial surgical site infection occurred in three cases, all managed conservatively. Importantly, no cases of permanent neurological deficit were observed, underscoring that, with meticulous technique and planning, CNR can be managed safely even with complex anatomy. Endoscopic discectomy, performed in one patient, yielded effective decompression and recovery with minimal morbidity. Although the sample size was limited, this finding is consistent with the work of Goldberg et al., who have advocated for minimally invasive spine surgery in appropriate cases [11]. Moreover, Nakajima et al. have demonstrated promising results with full-endoscopic posterior lumbar interbody fusion, suggesting a potential future direction in managing select CNR patients [12]. Our findings reinforce and expand upon the existing body of evidence regarding CNR surgical outcomes. Table 3 compares our key outcome metrics with those reported in other significant studies.

Table 3. Comparison of Current Study with Selected Literature

Study	No. of Patients	Procedure(s)	Symptom Relief (%)	Recurrence (%)	Complications (%)	Notes
Current Study (2025)	10	TLIF, Laminectomy, Endoscopic	80%	30%	30%	TLIF superior in stability and symptom durability

Takagi et al. [1]	Case report	TLIF	Good outcome	Yes (long-term)	Not reported	Recurrence attributed to segmental degeneration
Francio et al. [5]	Literature Review	Decompression ± Fusion	75–90 %	20–30 %	Varies	Recommends decompression + stabilization in CNR
Bydon et al. [6]	Multi-center	TLIF	85–90 %	~20 %	15–25 %	Emphasizes stabilization in elderly, complex anatomy
Basani et al. [9]	Review	Minimally Invasive TLIF	80–90 %	25 %	25–35 %	Complication risk elevated in CNR due to nerve handling
Goldberg et al. [11]	Review	Endoscopic Surgery	70–85 %	Not defined	Low	Advocates for less invasive approaches when feasible

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Despite satisfactory initial outcomes, the possibility of adjacent segment disease, especially following fusion, remains a concern. Our findings reaffirm the importance of long-term imaging follow-up and patient education regarding rehabilitation and activity modification. Core strengthening and avoidance of excessive mechanical strain may mitigate recurrence risks. In cases involving fusion, clinical monitoring for signs of adjacent segment degeneration should be routine, as emphasized in recent studies on lumbar biomechanics [6,10]. The results of this study support a personalized approach to CNR, integrating advanced preoperative imaging, anatomically guided surgical technique, and long-term follow-up. In anatomically complex or unstable cases, TLIF remains a reliable strategy. However, endoscopic alternatives should be further explored, especially for isolated foraminal pathology in younger, stable patients. To validate and refine these conclusions, larger prospective, multicenter trials with standardized outcome measures and imaging protocols are needed. Comparative studies between TLIF, laminectomy, and minimally invasive approaches could help define clearer surgical algorithms for CNR.

CONCLUSION:

In conclusion, CNR is a surgically manageable condition when approached with individualized planning, thorough imaging, and appropriate selection of surgical technique. Further prospective, multicenter studies are needed to refine treatment algorithms and validate the role of minimally invasive techniques in this challenging yet treatable spinal pathology.

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