Impact of Posterior Cord Compression from Ligamentum Flavum on Clinical Outcomes Following ACDF or CDR

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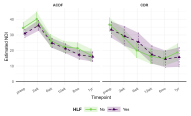
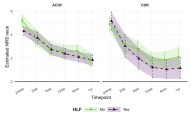
INTRODUCTION: ACDF and CDR are established surgical interventions for cervical degenerative disc disease, primarily addressing spinal canal stenosis from the anterior side. Cord compression from hypertrophied ligamentum flavum was reported to be associated with less favorable outcome following ACDF in patients with myelopathy. No previous literature investigates the effect of HLF on outcomes in patients with CDR for myelopathy. The aim of this study is to evaluate the impact of posterior compression by ligamentum flavum on clinical outcomes between patients undergoing ACDF or CDR.

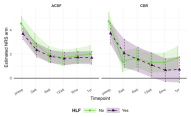
METHODS: A retrospective study was performed on patients following 1- or 2-level ACDF or CDR for cervical myelopathy or myeloradiculopathy. Patients with cervical deformity, fracture, or OPLL were excluded. Preoperative MRI parameters included ligamentum flavum thickness (LF, mm), sagittal spinal canal diameter (mm), presence of high signal intensity on T2-weighted images, and posterior cord compression graded by the CCLF system at each corresponding level. LF thickness and canal diameter were each normalized to their respective values at the C2/3 disc level. In patients undergoing two-level surgery, we recorded LF hypertrophy, canal diameter, T2 hyperintensity, and CCLF grade at the most severely affected level. Hypertrophied ligamentum flavum (HLF) was dichotomized as “no hypertrophy” (Non-HLF) for CCLF grade 0 and “hypertrophy” (HLF) for grades 1 or 2 (Fig. 1). PROMs included Neck Disability Index (NDI), Numerical Rating Scale (NRS) for neck and arm, and SF-12 PCS. Multivariable linear mixed-effects models (LMMs) were used for longitudinal outcome assessments. IPTW-adjusted LMM was utilized to compare outcomes in patients with HLF between ACDF and CDR.

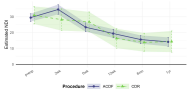
RESULTS: A total of 240 patients were assessed, of whom 228 met the inclusion criteria, with 160 ACDF and 68 CDR (Table 1). Both groups experienced significant improvements in NDI, NRS neck and arm over time ($F(5, 835.67) = 70.03$, $p < 0.001$) (Fig.2,3,4). HLF status did not significantly influence these outcomes in both ACDF and CDR cohorts ($F(5, 835.68) = 0.65$, $p = 0.66$). Additional Subgroup analyses by existing of radiculopathy, and number of surgical levels revealed no significant impact of HLF. IPTW-adjusted comparisons in HLF patients with balanced-cohort showed no significant difference in NDI trajectories between ACDF and CDR ($F(5, 472.19) = 1.30$, $p = 0.26$)(Fig.5). In overall cohort, 62 ACDF patients and 24 patients were followed-up by MRI with a mean follow-up of 25.1 ± 12.9 months. Normalized canal diameter was significantly improved in both ACDF (15.6% improvement, $p < 0.001$) and CDR (5.6%, $p < 0.001$), while ACDF was significantly more effective ($p = 0.029$). Ligamentum flavum was improved in ACDF (20.0% reduction in normalized thickness, $p = 0.017$), while CDR did not show significant reduction (-12.8%, $p = 0.35$). This led to significant differences in ligamentum flavum improvement ($p = 0.037$).

DISCUSSION AND CONCLUSION: Our study suggested that mild to moderate HLF are not independently associated with worse clinical outcomes following CDR compared to ACDF. Both surgical approaches were associated with significant improvements in patient-reported outcomes. These results suggest that CDR may be safely offered to carefully selected patients with mild ligamentum flavum hypertrophy, challenging the traditional view that excludes such cases from arthroplasty. Furthermore, ACDF demonstrated clinical benefit even in patients with more severe posterior compression, supporting its role in a wider range of degenerative conditions. In both cases, a careful patient selection and accurate preoperative planning remains essential to achieving favorable outcomes.









		ACDF	CDR	p
N		160	68	
Age, yr (mean (SD))		**59.2 (11.1)**	**44.8 (9.5)**	**<0.001**
Sex, male (%)		**98 (61.3)**	**36 (52.9)**	**0.270**
BMI, kg/m² (mean (SD))		28.2 (5.0)	26.4 (6.6)	0.017
Race, n (%)				0.658
	Asian	7 (4.4)	1 (1.5)	
	Black	5 (3.1)	2 (2.9)	
	Other	12 (7.5)	7 (10.3)	
	White	136 (85.0)	58 (85.3)	
ccl (mean (SD))		**1.8 (0.8)**	**1.1 (0.7)**	**<0.001**
opdon_ccl (mean (SD))		**1.5 (1.9)**	**0.4 (0.7)**	**<0.001**
asa_class (%)				
	1	11 (6.9)	17 (25.0)	
	2	128 (80.0)	50 (73.5)	
	3	21 (13.1)	1 (1.5)	
num_levels = 2 (%)		**105 (66.4)**	**28 (29.4)**	**<0.001**
num_segment = 1 (%)		**55 (34.4)**	**40 (58.8)**	0.010
preop_ndi (mean (SD))		35.2 (19.5)	39.4 (18.1)	0.105
preop_vas_neck (mean (SD))		4.5 (3.0)	3.2 (2.7)	0.095
preop_vas_arm (mean (SD))		4.8 (3.1)	4.4 (3.0)	0.419
preop_sf12pcs (mean (SD))		30.2 (9.3)	30.2 (9.3)	0.187

BMI, body mass index; CCI, Charlson Comorbidity Index; ASA class, American Society of Anesthesiologist Physical Status Classification; NDI, Neck Disability Index.

p<0.05 shown in bold.