Shorter Length of Stay and Increased Return to Work with Cervical Disc Arthroplasty Versus Anterior Cervical Discectomy and Fusion

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INTRODUCTION:

Anterior cervical discectomy and fusion (ACDF) and cervical disc arthroplasty (CDA) are established surgical options for the treatment of cervical radiculopathy, myelopathy, and cervical degenerative disc disease. However, current literature does not demonstrate a clear benefit between ACDF or CDA. The primary objective of this study is to compare the outcomes of ACDF and CDA for patients enrolled in the Michigan Spine Surgery Improvement Collaborative (MSSIC) database. Secondary objectives include assessment of early complications, procedural/perioperative outcomes, and patient-reported outcome measures after both ACDF and CDA.

METHODS:

Patients undergoing 1 or 2 level ACDF or CDA surgery were included. A 4:1 propensity score matching analysis was performed between ACDF and CDA, balanced exactly on levels fused/replaced, and using nearest neighbor of propensity scores in common support region. Covariates included in the matching were age, gender, race, education, BMI, diabetes, coronary artery disease, hypertension, COPD, ASA > 2, independent ambulation pre-op, private insurance, levels (which were specified to be an exact match), current smoking status, pre-op daily opioid use, and duration of symptoms. Univariate comparisons were performed both pre- and post-propensity score matching.

RESULTS:

A total of 10,991 patients undergoing surgery between January 4, 2016 and November 5, 2021 were included in the analysis. After matching, there were 3552 patients in the ACDF group and 888 patients in the CDA group. All discussed results are post-propensity score matching. Demographics yielded significant differences in age (48.8 ± 10.0 years and 46.6 ± 10.8 for ACDF vs CDA, respectively; $p < 0.001$) and pre-operative scoliosis (11% vs 9%; $p = 0.048$). Other demographic criteria were similar. There was no difference in preoperative duration of symptoms, foraminal stenosis, or central stenosis ($p > 0.05$); however, the CDA group had a higher prevalence of disc herniation ($p = 0.002$) and the ACDF group had a higher prevalence of myelopathy ($p<0.001$). Preoperative results are presented in Table 1.

Regarding outcomes, length of surgery in hours was increased in the CDA group (1.7 ± 0.9 CDA vs 1.5 ± 0.7 ACDF; $p < 0.001$) while length of stay in days was decreased (1.0 ± 1.0 CDA vs 1.4 ± 1.8 ACDF; $p < 0.001$). Patients who underwent CDA were more likely to be discharged home (100% CDA vs 98% ACDF; $p = 0.002$) and experience an outpatient surgery defined as less than 23 hours hospital stay (62% CDA vs 51% ACDF; $p < 0.001$). Estimated blood loss was similar for both groups ($p = 0.089$). There was a higher incidence of postoperative complications, including urinary retention, readmission, surgical site infection, return to OR, new or worsening radicular findings, cerebrospinal fluid leak, and myelopathy, in the ACDF group (25% ACDF vs 21% CDA; $p = 0.022$). At 1 year postop, significantly more patients were satisfied with their surgery in the CDA group (87% CDA vs 82% ACDF; $p = 0.049$). No significant differences in satisfaction were observed at 90 days or 2 years. No significant differences were observed in PROMIS, EQ-5D, neck pain, and arm pain minimal clinically important differences (MCIDs). Return to work favored CDA at 90 days (78% in CDA vs 71% in ACDF; $p = 0.043$) and 2 years (92% in CDA vs 83% in ACDF; $p = 0.049$). Outcome results are presented in Table 2.

DISCUSSION AND CONCLUSION:

Patients undergoing ACDF and CDA demonstrated similar preoperative characteristics. Postoperatively, patients undergoing CDA were more likely to be discharged home and experience an outpatient procedure. In addition, there were fewer complications in patients who underwent CDA. Furthermore, patients who underwent CDA were more satisfied with their surgery at 1 year and had higher rates of return to work at 90 days and 2 years after surgery. Further investigation is needed to further elucidate the significance of these postoperative benefits seen with CDA.

Table 1: Preoperative Univariate ACDF vs CDA Comparison

		Pre-Matching			Post-Matching		
Variable		ACDF (N= 9934)	CDA (N= 1057)	p-value	ACDF (N= 3552)	CDA (N= 888)	p-value
Age		55.2 ± 11.4	46.8 ± 10.8	**<0.001**	48.8 ± 10.0	46.6 ± 10.8	**<0.001**
Male		4731 (48%)	481 (46%)	0.188	1651 (46%)	412 (46%)	0.964
Race	Black	556 (6%)	53 (5%)	0.244	160 (5%)	43 (5%)	0.790
	Missing	3867 (39%)	383 (36%)		1392 (39%)	334 (38%)	
	Other	269 (3%)	30 (3%)		100 (3%)	23 (3%)	
	White	5228 (53%)	589 (56%)		1900 (53%)	488 (55%)	
BMI		30.7 ± 6.8	29.6 ± 6.2	**<0.001**	30.2 ± 6.7	29.8 ± 6.4	0.072
Diabetes		2056 (21%)	111 (11%)	**<0.001**	457 (13%)	98 (11%)	0.140
ASA > 2		5077 (51%)	324 (31%)	**<0.001**	1270 (36%)	277 (31%)	**0.011**
Independent Ambulation Pre-op		8890 (89%)	1015 (96%)	**<0.001**	3395 (96%)	856 (96%)	0.281
Private Insurance		5615 (57%)	756 (72%)	**<0.001**	2430 (68%)	626 (70%)	0.231
Levels	1	5106 (51%)	732 (69%)	**<0.001**	2436 (69%)	609 (69%)	1.000
	2	4828 (49%)	325 (31%)		1116 (31%)	279 (31%)	
Current Smoker	No	4810 (48%)	523 (49%)	**0.002**	1692 (48%)	435 (49%)	0.465
	Yes	1329 (13%)	176 (17%)		534 (15%)	141 (16%)	
	Missing	3795 (38%)	358 (34%)		1326 (37%)	312 (35%)	
Pre-op Daily Opioid Use	No	3504 (35%)	428 (40%)	**0.002**	1416 (40%)	373 (42%)	0.453
	Yes	2548 (26%)	262 (25%)		780 (22%)	194 (22%)	
	Missing	3882 (39%)	367 (35%)		1356 (38%)	321 (36%)	
Duration of Symptoms	Less than 3 months	1401 (14%)	157 (15%)	**<0.001**	542 (15%)	140 (16%)	0.568
	Greater than 3 months but less than 1 year	2803 (28%)	355 (34%)		1152 (32%)	302 (34%)	
	1 year or more	5148 (52%)	471 (45%)		1668 (47%)	394 (44%)	
	Not documented	582 (6%)	74 (7%)		190 (5%)	52 (6%)	
Disc Herniation		6791 (68%)	837 (79%)	**<0.001**	2661 (75%)	710 (80%)	**0.002**
Foraminal Stenosis		7973 (80%)	839 (79%)	0.493	2903 (82%)	737 (83%)	0.380
Central Stenosis		6507 (66%)	648 (61%)	**0.007**	2303 (65%)	582 (66%)	0.694
Radicular Symptoms with or without Neck Pain		9474 (95%)	1027 (97%)	**0.007**	3418 (96%)	863 (97%)	0.170
Myelopathy with or without Neck or Arm Pain		3379 (34%)	238 (23%)	**<0.001**	1042 (29%)	212 (24%)	**0.001**

Table 2: Perioperative and Postoperative Outcomes ACDF vs CDA

		Pre-Matching			Post-Matching		
Variable		ACDF	CDA	p-value	ACDF	CDA	p-value
Surgery Length (Hours)		1.6 ± 0.9	1.7 ± 0.9	0.081	1.5 ± 0.7	1.7 ± 0.9	**<0.001**
LOS (Days)		1.6 ± 2.2	1.1 ± 1.0	**<0.001**	1.4 ± 1.8	1.0 ± 1.0	**<0.001**
Estimated Blood Loss (cc)		44.8 ± 63.3	45.2 ± 58.2	0.854	37.8 ± 49.5	40.9 ± 43.5	0.089
Discharged Home		9554 (96%)	1049 (99%)	**<0.001**	3481 (98%)	884 (100%)	**0.002**
Outpatient (<23 Hour Stay)		4160 (42%)	611 (58%)	**<0.001**	1812 (51%)	550 (62%)	**<0.001**
PROMIS MCID	90 Days	1731/3145 (55%)	213/340 (63%)	**0.007**	644/1106 (58%)	164/274 (60%)	0.625
	1 Year	1273/2152 (59%)	165/237 (70%)	**0.002**	455/714 (64%)	129/181 (71%)	0.057
	2 Years	889/1524 (58%)	102/145 (70%)	**0.005**	326/502 (65%)	76/110 (69%)	0.406
Patient Satisfaction	90 Days	3988/4657 (86%)	420/481 (87%)	0.314	1380/1613 (86%)	342/359 (87%)	0.601
	1 Year	2697/3299 (82%)	325/374 (87%)	**0.014**	890/1087 (82%)	261/301 (87%)	**0.049**
	2 Years	1845/2243 (82%)	186/219 (85%)	0.320	604/730 (83%)	143/165 (87%)	0.220
EQ-5D MCID	90 Days	1318/2600 (51%)	151/278 (54%)	0.251	471/928 (51%)	123/225 (55%)	0.292
	1 Year	918/1702 (54%)	114/196 (58%)	0.261	335/627 (53%)	101/165 (61%)	0.074
	2 Years	751/1345 (56%)	77/131 (59%)	0.517	236/418 (56%)	56/94 (60%)	0.581
Return to Work	90 Days	967/1492 (65%)	177/225 (79%)	**<0.001**	505/715 (71%)	146/187 (78%)	**0.043**
	1 Year	861/1083 (80%)	139/166 (84%)	0.204	417/501 (83%)	114/136 (84%)	0.870
	2 Years	640/824 (78%)	98/106 (92%)	**<0.001**	297/356 (83%)	79/86 (92%)	**0.049**
Neck Pain MCID	90 Days	1734/2833 (61%)	198/308 (64%)	0.292	637/1026 (62%)	153/245 (62%)	0.916
	1 Year	1234/1915 (64%)	161/231 (70%)	0.113	403/636 (63%)	124/177 (70%)	0.099
	2 Years	887/1368 (65%)	92/132 (70%)	0.263	305/458 (67%)	65/98 (66%)	0.959
Arm Pain MCID	90 Days	1712/2524 (68%)	187/266 (70%)	0.411	651/933 (70%)	144/212 (68%)	0.598
	1 Year	1156/1708 (68%)	144/196 (73%)	0.099	410/592 (69%)	114/150 (76%)	0.105
	2 Years	828/1199 (69%)	88/115 (77%)	0.096	280/409 (68%)	68/88 (77%)	0.102

[1]Includes the following complications: Any mortality, Axial pain (new or worsening), Claudication, DVT, Ileus, MI, Neuro deficit (stroke), Return to OR after discharge, Unplanned return to OR during admission, Readmission, PE, Radicular findings (new or worsening), SSI, Urinary retention, UTI, Weakness (new or worsening), Wound dehiscence, CSF leak, and Myelopathy