

Introduction

Anterior cervical discectomy and fusion (ACDF) is among the mainstays of operative management for cervical spondylosis¹. Among spine surgeons, there is debate as to the clinical benefit provided by intraoperative microscope use during this procedure^{2,3,4}. While the technical advantages provided by the microscope should allow for a safer and more precise decompression of the entrapped neural elements, its use has not been universally adopted by all surgeons performing ACDF. This warrants close examination as it is a nonessential addition to ACDF and represents either a valuable adjunct or a modifiable risk factor. The primary goal of this study is to compare both the immediate and long-term outcomes in patients undergoing ACDF with intraoperative microscope to those who undergo ACDF without intraoperative microscope use.

Methods

A retrospective cohort analysis was done using patient data collected from the PearlDiver database from 2010 to 2019. Patients who underwent single-level ACDF with at least two-year follow up were identified. These patients were divided into two cohorts: ACDF with intraoperative use and ACDF without intraoperative microscope use. Univariate and multivariable analyses were performed to determine 1-year and 2-year surgical complications including anterior revision, posterior revision, hardware removal, hardware replacement, incision and drainage, decompression laminectomy, and dural tear. Analysis of 90-day postoperative complications was also done for each cohort.

Results

In total, 80,525 patients undergoing ACDF were included in the study. Of these, 4,934 underwent ACDF with microscope use and 75,591 underwent ACDF without intraoperative microscope. Patients in the microscope group were found to be younger, but with a greater number of comorbidities. Multivariable analysis showed greater odds at 1-year and 2-years for having undergone incision and drainage, decompression laminectomy, and dural tear in patients undergoing ACDF with intraoperative microscope use. No significant difference was found in 1- and 2-year anterior or posterior revision rate among the two cohorts. Patients whose ACDF involved microscope use also had greater odds of surgical site infection, blood transfusion, stroke, and deep vein thrombosis within 90 days following the index procedure.

Discussion

The existing literature on the inclusion of intraoperative microscope to ACDF is varied. While many authors have found its use leads to satisfactory results, our data challenges its long-term benefit. Our study suggests the addition of intraoperative microscope to ACDF may be associated with increased medical and surgical complications. Future studies which focus on stratifying surgeon-specific preference and experience with the microscope should be performed to further investigate this association before evidence-based recommendations can be made.

Table 1. Demographics and Comorbidities of Patients Undergoing Anterior Cervical Discectomy and Fusion with Intraoperative Microscope Use and Without Intraoperative Microscope Use

Category	ACDF Microscope		ACDF No Microscope		p-value
	Number	Percent (%)	Number	Percent (%)	
Total	4934		75591		
Age (Yr)	54.36		55.13		<0.001
<50	1602	32.5%	23606	31.2%	
50-59	1728	35.0%	25348	33.5%	
60-69	1100	22.3%	17941	23.7%	
70-79	487	9.9%	8650	11.4%	
>80	17	0.3%	46	0.1%	
Gender					0.419
Male	2220	45.0%	34467	45.6%	
Female	2714	55.0%	41124	54.4%	
CHF	508	10.3%	7084	9.4%	0.033
Arrhythmias	1551	31.4%	23491	31.1%	0.609
Valvular Disease	853	17.3%	11732	15.5%	<0.001
Pulmonary Disorders	231	4.7%	3379	4.5%	0.509
PVD	926	18.8%	13075	17.3%	0.009
HTN	2990	60.6%	45026	59.6%	0.156
Paralysis	291	5.9%	4458	5.9%	1.000
COPD	1851	37.5%	27329	36.2%	0.056
Diabetes Mellitus	1531	31.0%	22719	30.1%	0.153
Hypothyroidism	1198	24.3%	17809	23.6%	0.255
CKD	531	10.8%	8053	10.7%	0.829
Liver Disease	824	16.7%	12298	16.3%	0.438
PUD	108	2.2%	1522	2.0%	0.426
Lymphoma	56	1.1%	618	0.8%	0.022
Cancer Metastasis	82	1.7%	1488	2.0%	0.146
Cancer No Metastasis	480	9.7%	7405	9.8%	0.896
Rheumatoid Arthritis and CVD	963	19.5%	14057	18.6%	0.112
Coagulopathy	331	6.7%	4335	5.7%	0.005
Fluid and electrolyte disorders	1458	29.6%	21261	28.1%	0.033
Deficiency anemia	152	3.1%	2240	3.0%	0.669
Alcohol abuse	718	14.6%	9591	12.7%	<0.001
Drug abuse	89	1.8%	1399	1.9%	0.855
Psychoses	758	15.4%	10480	13.9%	0.003
Depression	223	4.5%	3161	4.2%	0.267
Obesity (BMI>30)	2158	43.7%	34417	45.5%	0.015
Smoking	994	20.1%	15859	21.0%	0.168

Yr: Year; CHF: Congestive Heart Failure; PVD: Peripheral Vascular Disease; HTN: Hypertension; COPD: Chronic Obstructive Pulmonary Disorder; CKD: Chronic Kidney Disease; PUD: Peptic Ulcer Disease; CVD: Collagen Vascular Diseases; BMI: Body Mass Index; All p-value comparisons were made between the two groups of interest; bolding equates to significance of p<0.05

Table 3. Univariate Analysis of 90-Day Complications Following Anterior Cervical Discectomy Fusion with Intraoperative Microscope Use and Without Intraoperative Microscope Use

Category	ACDF Microscope		ACDF No Microscope		p-value
	Number	Percent (%)	Number	Percent (%)	
Total	4934		75591		
All Complications	821	16.6%	12552	16.6%	0.965
SSI	71	1.4%	659	0.9%	<0.001
Renal Failure	63	1.3%	1106	1.5%	0.318
Anemia	77	1.6%	1194	1.6%	0.965
Arrhythmia w/ afib	279	5.7%	4879	6.5%	0.028
Arrhythmia w/o afib	210	4.3%	3899	5.2%	0.006
Bleeding Transfusion	69	1.4%	316	0.4%	0.006
Blood Complication	48	1.0%	650	0.9%	0.453
Pneumonia	117	2.4%	1630	2.2%	0.340
Stroke	93	1.9%	1048	1.4%	0.005
Death	9***	0.2%	111	0.1%	0.662
DVT	54	1.1%	652	0.9%	0.107
Heart Failure	98	2.0%	1635	2.2%	0.436
Pulmonary Embolism	33	0.7%	466	0.6%	0.719
Respiratory Complication	92	1.9%	1368	1.8%	0.822
Sepsis	46	0.9%	722	1.0%	0.933
UTI	234	4.7%	3287	4.3%	0.202
Cellulitis	53	1.1%	757	1.0%	0.673
Neurological Complication	9***	0.2%	158	0.2%	0.813
Readmission	401	8.1%	6065	8.0%	0.816

***Per HIPAA requirements, <11 cohort sizes are not reportable; SSI: surgical site infection; w/ afib: with atrial fibrillation; w/o afib: without atrial fibrillation; DVT: Deep Vein Thrombosis; UTI: Urinary Tract Infection; Bolding indicates significance of p<0.05. Groups were analyzed with chi-squared analysis compared to one another.

Table 2. Univariate Analysis of 1 Year and 2 Year Surgical Outcomes Following Anterior Cervical Discectomy Fusion with Intraoperative Microscope Use and Without Intraoperative Microscope Use

Category	ACDF Microscope		ACDF No Microscope		p-value
	Number	Percent (%)	Number	Percent (%)	
Total	4934		75591		
1-Year Anterior Revision	15	0.3%	263	0.3%	0.701
1-Year Posterior Revision	215	4.4%	3089	4.1%	0.372
1-Year Hardware Removal	28	0.6%	304	0.4%	0.101
1-Year Hardware Replacement	27	0.5%	300	0.4%	0.135
1-Year Incision and Drainage	54	1.1%	560	0.7%	0.007
1-Year Decompressive Laminectomy	266	5.4%	3275	4.3%	<0.001
1-Year Dural Tear	20	0.4%	117	0.2%	<0.001
2-Year Anterior Revision	24	0.5%	412	0.5%	0.657
2-Year Posterior Revision	320	6.5%	4755	6.3%	0.606
2-Year Hardware Removal	35	0.7%	397	0.5%	0.106
2-Year Hardware Replacement	35	0.7%	410	0.5%	0.152
2-Year Incision and Drainage	75	1.5%	807	1.1%	0.004
2-Year Decompressive Laminectomy	355	7.2%	4602	6.1%	0.002
2-Year Dural Tear	30	0.6%	169	0.2%	<0.001

***Per HIPAA requirements, <11 cohort sizes are not reportable; Bolding indicates significance of p<0.05. Groups were analyzed with chi-squared analysis compared to one another.

Table 4. Multivariable Analysis of Surgical Outcomes and Complications Following Anterior Cervical Discectomy Fusion with Intraoperative Microscope Use and Without Intraoperative Microscope Use

Category	Odds Ratio	ACDF Microscope		P-value
		95% Confidence Interval (Lower)	95% Confidence Interval (Upper)	
Total				
1 year Hardware Removal	1.576	1.209	2.028	<0.001
1 year Hardware Replacement	1.478	1.121	1.918	0.004
1 year I&D	1.546	1.270	1.868	<0.001
1 year Decompression Laminectomy	1.327	1.213	1.449	<0.001
1 year Dural Tear	2.592	1.817	3.633	<0.001
2 year Hardware Removal	1.439	1.131	1.809	0.002
2 year Hardware Replacement	1.385	1.088	1.742	0.007
2 year I&D	1.499	1.271	1.759	<0.001
2 year Decompression Laminectomy	1.255	1.161	1.355	<0.001
2 year Dural Tear	2.787	2.094	3.671	<0.001
90 day SSI	1.632	1.368	1.934	<0.001
90 day Arrhythmia w/ afib	0.812	0.743	0.886	<0.001
90 day Arrhythmia w/o afib	0.771	0.698	0.850	<0.001
90 day Blood Transfusion	1.357	1.034	1.756	0.023
90 day Stroke	1.293	1.107	1.503	0.001
90 day DVT	1.188	0.973	1.440	0.085

SSI: surgical site infection; w/ afib: with atrial fibrillation; w/o afib: without atrial fibrillation; DVT: Deep Vein Thrombosis. Bolding indicates significance of p<0.05

¹Muheremu A, Niu X, Wu Z, Muhammode Y, Tian W. Comparison of the short- and long-term treatment effect of cervical disk replacement and anterior cervical disk fusion: a meta-analysis. Eur J Orthop Surg Traumatol. 2015 Jul;25 Suppl 1:S87-100. doi: 10.1007/s00590-014-1469-1. Epub 2014 May 5. PMID: 24791930.

²Hankinson HL, Wilson CB. Use of the operating microscope in anterior cervical discectomy without fusion. J Neurosurg. 1975 Oct;43(4):452-6. doi: 10.3171/jns.1975.43.4.0452. PMID: 1159482.

³Omid-Kashani, Farzad et al. "Impact of Age and Duration of Symptoms on Surgical Outcome of Single-Level Microscopic Anterior Cervical Discectomy and Fusion in the Patients with Cervical Spondylotic Radiculopathy." *Neuroscience journal* vol. 2014 (2014): 808596. doi:10.1155/2014/808596

⁴Adogwa O, Elsamadicy A, Reiser E, Ziegler C, Freischlag K, Cheng J, Bagley CA. Comparison of surgical outcomes after anterior cervical discectomy and fusion: does the intra-operative use of a microscope improve surgical outcomes. J Spine Surg. 2016 Mar;2(1):25-30. doi: 10.21037/jss.2016.01.04. PMID: 27683692; PMCID: PMC5039832.