Evolving Patient Selection Profile for the Utilization of Cervical Disk Arthroplasty (2015-2020): A Retrospective Analysis

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INTRODUCTION: Cervical disk arthroplasty (CDA) is an evolving technology used to manage various degenerative cervical spine conditions including disc herniation, degenerative disc disease, and cervical radiculopathy. This approach has demonstrated both favorable short-term and medium-term outcomes. In comparison to anterior cervical discectomy and fusion (ACDF), CDA offers additional advantages including preserving the physiological flexion-extension motion of the cervical spine, reducing the occurrence of adjacent segment disease, and expediting the healing process. Because CDA is a relatively new procedure, the surgical indications require refinement based on growing experience and data. In this retrospective analysis, we investigated how patient selection factors for CDA have evolved between 2015 and 2020.

METHODS: We conducted a retrospective analysis using a comprehensive national insurance database. This database contains data on 151 million individual patients followed longitudinally through most of private and government insurance products. Our objective was to identify patients who underwent single- or two-level cervical disk arthroplasty (CDA) between 2015 and 2020, as indicated by the CPT codes 22856 and 22858. The data was categorized based on patient factors recorded prior to the index surgery, including obesity, tobacco use, fibromyalgia, osteoporosis, diabetes, preoperative opioid use, insurance status, and multi-level disease. To assess changes over time, we calculated the compound annual growth rate (CAGR) and overall surgical case changes for each patient factor group of interest between 2015 and 2020. We performed a Chi-squared analysis to compare the frequency of patient factors between the two time periods and applied the Bonferroni correction to account for multiple comparisons and considered a significant statistical difference at $p < 0.01$.

RESULTS: A total of 20,575 CDA cases were identified between 2015 and 2020, with a compound annual growth rate (CAGR) of 11.1% during this period. However, within the overall growth, there was a decrease in the proportion of cases among patient populations with tobacco use (CAGR -5.25%), fibromyalgia (CAGR -8.33%), osteoporosis (CAGR -6.95%), diabetes (CAGR -3.36%), and preoperative opioid use (CAGR -4.97%), resulting in an overall reduction of -23.60%, -35.60%, -30.20%, -15.70%, and -22.50%, respectively (all $p < 0.001$). Interestingly, the only patient factor that saw an increase in CDA utilization was obesity (CAGR 2.68%), with an overall growth of 14.10% during the study period ($p < 0.001$). Additionally, there was an increase in the proportion of patients undergoing two-level surgery (CAGR = 12.8%, $p < 0.001$) and Medicaid patients (CAGR = 11.1%, $p < 0.001$).

DISCUSSION AND CONCLUSION:

CDA is a promising technology with well-established benefits for treating various cervical spine conditions, and its utilization has increased over the past decade. The expansion of this technology, however, has not been consistent across patient populations with specific risk factors. The use of CDA has significantly declined in patients with a history of either tobacco use, fibromyalgia, osteoporosis, diabetes, or preoperative opioid use. The decrease in CDA utilization among patients with a history of tobacco use and osteoporosis is especially noteworthy, considering that these patients could potentially benefit the most from a procedure that does not rely on bone fusion. Obesity was the only patient risk factor examined in this study that had an increase in CDA utilization. The increase in the surgery rate for multi-level surgery and the Medicaid population likely reflects policy changes more than patient-related factors.

Given the annual growth of CDA procedures, it would be expected to see a wide utilization across various patient demographics, particularly as surgeons become more experienced with the procedure. Because of the purported advantages, we may even expect that the indications for CDA would expand to patient populations who are not ideal candidates for alternative operations, such as those at a higher risk of nonunion. However, our data suggest the opposite trend, indicating a narrowing of indications for CDA despite the overall growth of this technology. The reasons for the decrease in CDA utilization among patients with individual risk factors are unclear, especially since there are no FDA guidelines indicating absolute contraindications based on these factors. It is possible that surgeons are modifying their indications based on their individual experience.

It is important to note that we did not investigate whether these patient populations are being treated using more traditional methods due to perceived risk. Further research is needed to better understand the underlying reasons behind these trends and to inform clinical decision making in the management of cervical spine conditions.

	2015	2016	2017	2018	2019	2020	CAGR	Overall Growth	P-value
Total Cervical Disc Arthroplasty Cases	2352	2735	3387	3824	4435	4024	11.1%	71.10%	p<0.001
	2015	2016	2017	12018	2019	2020	CAGR	Overall Growth	P-value
Obesity	29.00%	30.20%	32.30%	31.90%	34.20%	33.10%	2.68%	14.10%	p<0.001
Tobacco	25.80%	21.80%	22.90%	21.60%	20.70%	19.70%	-5.25%	-23.60%	p<0.001
Fibromyalgia	15.60%	13.00%	11.20%	11.80%	10.50%	10.10%	-8.33%	-35.60%	p<0.001
Ostoporosis	4.30%	4.40%	4.40%	3.60%	4.10%	3.00%	-6.95%	-30.20%	p<0.001
Diabetes	21.00%	19.40%	20.60%	19.70%	18.20%	17.70%	-3.36%	-15.70%	p<0.001
Opiod use preop	53.20%	52.90%	48.80%	41.30%	40.10%	41.20%	-4.97%	-22.50%	p<0.001

Table 1. Proportions of patient risk factors, total CDA growth, and annual CDA stratified by preoperative patient variables between 2015 and 2020.