Clinical Outcomes and Recovery Timelines Following 1-, 2-, and 3-Level Anterior Cervical Discectomy and Fusion: A Comparative Analysis of PROMs and MCID Achievement

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INTRODUCTION: Anterior cervical discectomy and fusion (ACDF) is a commonly performed procedure for the treatment of cervical degenerative disc disease, with over 130,000 cases performed annually. While single- and two-level ACDFs are well-studied and considered safe and effective, research on multi-level procedures, particularly those involving three levels, is limited. When assessing surgical outcomes, patient-reported outcome measures (PROMs) and the concept of a minimum clinically important difference (MCID) are critical for quantifying a patient's functional recovery and clinical improvement. However, no prior study has directly compared MCID achievement rates or the timing of this achievement across 1-, 2-, and 3-level ACDFs. Our study aimed to fill this gap by comparing clinical outcomes, PROMs, and MCID achievement across these three cohorts. We hypothesized that patients undergoing 3-level ACDFs would have worse PROM improvement, lower MCID achievement rates, and a longer time to achieve MCID compared to the other groups.

METHODS: A retrospective cohort study was conducted on patients who underwent primary ACDF at a single academic institution from 2014-2020. Patients were categorized into 1-level, 2-level, and 3-level cohorts. Inclusion criteria were age ≥18 years and elective ACDF. Exclusion criteria included concomitant posterior fusion, surgery for indications of infection/cancer/trauma, or incomplete preoperative and 1-year postoperative PROMs. Demographic data (age, sex, race, BMI), comorbidities (CCI, diabetes, hypertension), and perioperative details (operative time, LOS, complications) were collected from Structured Query Language searches and manual chart reviews. PROMs, including SF-12 (MCS, PCS), VAS Neck and Arm, NDI, and mJOA, were assessed preoperatively and at 3, 6, and 12 months. MCID was calculated for VAS Neck, VAS Arm, NDI, and mJOA using previously reported thresholds. The proportion of patients achieving MCID and the time to achievement were recorded. $P < 0.05$ was considered statistically significant.

RESULTS SECTION: The study included 476 patients: 148 (31.1%) had 1-level, 211 (44.3%) had 2-level, and 117 (24.6%) had 3-level ACDFs. Patients in the 3-level cohort were significantly older than those in the 1- and 2-level cohorts (59.8 vs. 55.4 years, $P = 0.007$; 59.8 vs. 57.1 years, $P = 0.028$). The 3-level group also had a higher proportion of myelopathy diagnoses compared to both the 1-level (58.1% vs. 32.4%, $P < 0.001$) and 2-level cohorts (58.1% vs. 39.8%, $P = 0.003$). While overall complication rates were similar, the 3-level ACDF group had a higher rate of dysphagia lasting beyond 6 months compared to the 1-level (14.3% vs. 0%, $P = 0.025$) and 2-level groups (14.3% vs. 6.67%, $P = 0.025$). Regarding PROMs, the 3-level cohort consistently had worse scores for MCS, PCS, NDI, and mJOA at various postoperative timepoints compared to the other groups. The 2-level cohort showed greater mJOA improvement at 12 months than both the 1-level (1.93 vs. 0.82, $P = 0.006$) and 3-level groups (1.93 vs. 1.15, $P = 0.018$). While MCID achievement for VAS Neck, VAS Arm, and NDI was comparable across all groups, the 3-level cohort had a lower proportion of patients achieving mJOA MCID than the 2-level cohort at 3 and 6 months ($P < 0.05$). Notably, the 2-level group achieved mJOA MCID significantly faster than both the 1- and 3-level groups ($P < 0.05$).

DISCUSSION: Our findings demonstrate that 3-level ACDF is associated with older patient demographics and a higher prevalence of myelopathy, reflecting its use in more advanced disease. Consistent with our hypothesis, patients undergoing 3-level ACDF experienced a slower and less robust recovery than those with 1- or 2-level procedures, evidenced by consistently worse PROMs and lower rates of mJOA MCID achievement. The higher rate of persistent dysphagia past 6 months in the 3-level cohort suggests that the extensive surgical dissection required for these procedures may lead to a longer duration of this complication. Interestingly, the 2-level group had faster time to mJOA MCID achievement compared to both the 1- and 3-level cohorts. This may be explained by a "ceiling effect" in which the 1-level patients who have less severe preoperative symptoms were limited in their potential for a large-magnitude improvement. Future research should include long-term follow-up and direct radiographic assessment to further validate these findings.

SIGNIFICANCE/CLINICAL RELEVANCE: These findings provide valuable insights for preoperative patient counseling, highlighting the potential for a slower recovery trajectory after 3-level ACDFs.