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Poorer Preoperative Function Leads to Delayed Return to Work After Anterior Cervical Discectomy and Fusion for Degenerative Cervical Myelopathy

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ABSTRACT

Background: The factors that affect return to work (RTW) after anterior cervical discectomy and fusion (ACDF) for degenerative cervical myelopathy (DCM) remain unclear, especially in a non-Workers' Compensation setting. We aimed to (1) identify factors that influence RTW in patients undergoing ACDF (2) determine if early RTW plays a role in functional outcomes, quality of life, and satisfaction.

Methods: Prospectively collected data of 103 working adults who underwent primary ACDF for DCM were retrospectively reviewed. Patients were stratified into 2 groups: early RTW (≤ 60 days, $n = 42$) and late RTW (> 60 days, $n = 61$).

Results: The mean time taken to RTW was 34.7 and 134.9 days in the early and late RTW groups, respectively ($P < 0.001$). The early RTW group had significantly better preoperative Japan Orthopaedic Association (JOA) score and Neck Disability Index (NDI) ($P < 0.05$) and showed a trend toward higher 36-Item Short Form Physical Component Summary (PCS) ($P = 0.071$). The early RTW group also had significantly better postoperative JOA, NDI, and PCS at 6 months and less arm pain along with a trend toward better NDI at 2 years ($P = 0.055$). However, there was no difference in the change in outcome scores and a similar proportion in each group attained the minimal clinically important difference for each metric. At 2 years, 85.7% and 77.0% were satisfied in the early and late RTW groups, respectively ($P = 0.275$).

Conclusions: While working adults that RTW later tend to have poorer function preoperatively and up to 2 years postoperatively, surgeons may reassure them that they will likely experience the same degree of clinical improvement and level of satisfaction after ACDF.

Level of Evidence: Level 3, therapeutic study.

Cervical Spine

Keywords: anterior cervical discectomy and fusion, cervical fusion, myelopathy, return to work, outcomes, satisfaction, cervical spine

INTRODUCTION

Degenerative cervical myelopathy (DCM) is the most common cause of spinal cord dysfunction worldwide.¹ Faced with aging populations, clinicians will need to manage an increasing number of patients with degenerative changes in their spine.² The rate of surgical intervention for cervical spine disease has seen an exponential rise in the last few decades, with an accumulated cost burden of more than \$2 billion per year according to some estimates.³ As healthcare systems shift toward value-based care, it is imperative to determine which patients will receive the most benefit from high-cost procedures such as cervical spine surgery. As such, patient-reported outcomes have been increasingly prioritized to optimize healthcare delivery.

Return to work (RTW) after surgery represents one such outcome that has been gaining recognition in recent years, as a subgroup of working adults do not RTW as quickly as desired after spine surgery. It is known that patients receiving worker's compensation (WC) have lower RTW rates, with as low as 24% of patients returning to their jobs after lumbar spine surgery.⁴ Older age, permanent disability and psychological comorbidities have been negatively associated with RTW status in WC patients undergoing lumbar fusion.⁵ Relatively fewer studies have attempted to delineate the factors that predict ability to RTW after cervical spine surgery, and these have primarily been conducted in the WC setting.^{6–8} However, patients receiving WC are known to have poorer outcomes following treatment of cervical spine disease; therefore, these studies may not be applicable to the general population.^{9–11} In the

non-WC setting, few studies with small sample sizes or those not restricted to cervical spine surgery have determined a few factors negatively impacting the ability to RTW, including duration of preoperative sick leave, preoperative employment status, and postoperative neck pain (NP).^{12,13} Unfortunately, significant diagnostic and surgical heterogeneity still exists in the literature,¹⁴ despite a recent finding that different cervical fusion procedures for different indications may yield different RTW rates.^{6,7}

The perioperative factors that influence RTW after anterior cervical discectomy and fusion (ACDF) for DCM remain unclear, especially in a non-WC setting. Therefore, the aim of this study was to identify factors that influence the ability to RTW in patients undergoing ACDF and determine if early RTW plays a role in functional outcomes, health-related quality of life, and satisfaction after surgery.

METHODS

Following ethical approval (CIRB:2017/2628), a prospectively maintained registry was retrospectively reviewed for all patients who underwent primary ACDF for DCM between 2003 and 2014. All patients had complete preoperative and postoperative follow-up data at 6 months and 2 years. The indications for surgery included patients who had cervical myelopathy caused by cervical spondylosis and/or spondylolisthesis. Patients were excluded if they were younger than 18 years, underwent surgery for 3 or more levels, had previous cervical surgery, myelopathy due to nonspondylotic causes (eg, trauma, tumor, and infections) or neuromuscular disease. Of the 219 patients remaining available for review, a total of 103 working adults were included. No patients received WC. Patients were asked about their working status during preoperative and postoperative visits according to the North American Spine Society Questionnaire item 7, "After your most recent surgery, did you return to work?" and were given 5 options: (1) No, (2) Yes, with limitations, (3) Yes, with no limitations, (4) Never stopped working, (5) Did not work. The number of days taken to RTW was also recorded. Using these data, patients were stratified into 2 groups: early RTW (≤ 60 days, $n = 42$) and late RTW (> 60 days, $n = 61$).

All patients completed at least 12 weeks of unsuccessful conservative treatment prior to ACDF and had preoperative evaluation with cervical spine radiographs, computed tomography to rule out the presence of ossification of the posterior longitudinal ligament and magnetic resonance imaging. ACDF surgeries were performed by the senior authors of this study. A standardized postoperative rehabilitation program was conducted for all patients.

Demographic data including age, sex, body mass index (BMI), smoking status, and medical comorbidities were recorded. An independent healthcare professional performed the preoperative and postoperative assessment of all patients. All patients completed the American Academy of Orthopaedic Surgeons cervical questionnaire for neck pain and disability (NPD), neurogenic symptoms (NS), RTW, and return to full function, as well as other questionnaires including the Neck Disability Index (NDI), Japanese Orthopaedic Association (JOA) questionnaire, 36-Item Short Form Survey (SF-36), and visual analog scales (VAS) for NP and arm pain (AP). In this study, the medical outcome study approach proposed by Ware et al was used to derive 2 higher order summary scores from the 8 subscales of the SF-36: the Physical Component Summary (PCS) and Mental Component Summary (MCS).¹⁵ Summary scores were developed to aggregate the most highly correlated subscales and simplify analyzes without substantial loss of information. The JOA and mJOA are widely accepted standards for DCM assessment and separately evaluate lower and upper limb, sphincter, and sensory function. We used the JOA score as this has been validated and shown to have high interrater and intrarater reliability,¹⁶ whereas its modified version has not.

Clinical improvement measured by the various assessment tools was defined using the minimal clinically important difference (MCID). The MCID represents a critical threshold of change, compared with baseline, that is considered meaningful improvement to the patient. Previously published cut-off values of 2.5 for NP, 2.5 for AP, 7.5 for NDI, 4.1 for SF-36 PCS,¹⁷ and 1.25 for JOA¹⁸ were used to determine if a patient achieved the MCID. All outcome scores were evaluated again 6 months and 2 years postoperatively, together with an assessment of the patient's fulfillment of expectations and overall satisfaction with the outcome of surgery. Expectation and satisfaction scores were recorded using 7-level and 6-level Likert scales adapted from the North American Spine Society lower back pain instrument, respectively,¹⁹ with higher scores indicating poorer results. We then dichotomized the scores into satisfied/unsatisfied or expectations fulfilled/unfulfilled (Table 1).

Statistical Methods

All continuous data were expressed in terms of mean and standard deviation of the mean. Statistical analyzes were performed using the SPSS 20.0 (SPSS Inc., Chicago, IL, USA) software package. The student t test and χ^2 test were used to compare parametric and

Table 1. Evaluation of patient satisfaction and expectation fulfillment.

Score	Patient Satisfaction ^a Stratification	
1	Excellent	Satisfied
2	Very good	
3	Good	
4	Fair	Dissatisfied
5	Poor	
6	Terrible	
Score	Patient Expectation Fulfillment ^b Stratification	
1	Yes, totally	Fulfilled
2	Yes, almost totally	
3	Yes, quite a bit	
4	More or less	Not fulfilled
5	No, not quite	
6	No, far from it	
7	No, not at all	

^aQuestion adapted from Q53 North American Spine Society Low Back Pain Instrument.

^bQuestion adapted from Q48 North American Spine Society Low Back Pain Instrument.

proportion-based outcomes between groups, respectively. To minimize the effect of potential confounders such as age, gender, BMI, comorbidities, and, most importantly, the preoperative JOA and NDI,²⁰ multivariate regression analysis was used to control for these variables. Repeated measures analysis of variance was used to evaluate the change in scores from preoperative to 6 months and 2 years postoperatively in each group. We defined statistical significance at the 5% ($P \leq 0.05$) level.

RESULTS

Patient Demographics

The mean number of days taken to RTW was 34.7 in the early RTW group and 134.9 in the late RTW group ($P < 0.001$) (Table 2). There was no significant difference in age, gender, BMI, smoking status, or comorbidities ($P > 0.05$ for each), except for a slightly greater prevalence of hyperlipidemia in the late RTW group ($P = 0.039$).

Preoperative Factors Affecting RTW

The early RTW group had significantly better preoperative JOA, NPD, and NDI than the late RTW group ($P < 0.05$) and also showed a trend toward higher PCS scores ($P = 0.071$), suggesting that these patients had less functional impairment and bodily pain compared to those in the late RTW group.

Effect of Early RTW on Patient Outcomes

Both groups had a significant improvement in all outcome scores ($P < 0.05$) (Figure). The early RTW

Table 2. Patient demographics and preoperative clinical scores ($n = 103$).

	Early ($n = 42$)		Late ($n = 61$)		P Value
	Mean	SD	Mean	SD	
Age, y	53.0	7.7	53.0	10.3	0.975
Gender, %					
Male	64.3		70.5		0.507
Female	35.7		29.5		
BMI	24.9	4.5	25.3	4.3	0.632
Smoking status, %					
Never	69.0		57.4		
Former	16.7		13.1		0.198
Current	14.3		29.5		
Comorbidities, %					
Diabetes	14.3		16.4		0.772
Hypertension	26.2		41.0		0.122
Hyperlipidemia	14.3		32.8		0.039
Heart disease	7.1		4.9		0.636
Stroke	0.0		1.6		0.404
Kidney disease	0.0		1.6		0.404
Asthma	2.4		3.3		0.790
Osteoarthritis	14.3		4.9		0.098
Depression	0.0		0.0		1.000
No comorbidities	45.2		34.4		0.269
No. of levels, %					
1	52.4		42.6		0.329
2	47.6		57.4		
Length of Op, mins	127.8	30.1	135.2	44.0	0.392
Length of stay, d	2.9	1.6	3.3	2.4	0.397
Time taken to RTW, d	34.7	15.1	134.9	123.9	<0.001
Preop VAS NP ^a	2.9	3.2	4.0	3.2	0.089
Preop VAS AP ^a	2.6	3.3	2.9	3.3	0.678
Preop JOA	12.8	2.4	11.4	3.1	0.015
Preop NS ^a	44.3	23.3	48.0	27.3	0.469
Preop NPD ^a	24.8	17.5	36.6	21.6	0.004
Preop NDI ^a	21.2	16.2	33.4	19.9	0.001
Preop PCS	40.2	11.2	35.7	13.1	0.071
Preop MCS	47.7	11.3	46.1	12.4	0.499

^aA lower score is better.

Abbreviations: BMI, body mass index; JOA, Japanese Orthopaedic Association; MCS, Mental Component Summary; NDI, Neck Disability Index; NPD, neck pain and disability; NS, neurogenic symptoms; PCS, Physical Component Summary; RTW, return to work; VAS AM, visual analog scale arm pain; VAS NP, visual analog scale neck pain.

group had significantly better scores in most outcome measures at 6 months and 2 years (Table 3).

However, there was no difference in the change in scores from preoperative to 6 months and preoperative to 2 years ($P > 0.05$), except for greater NDI improvement in the late RTW group at 2 years ($P = 0.045$) (Figure). A similar proportion of patients in both groups had a change in scores that met the MCID for the various metrics ($P > 0.05$). Despite poorer outcome scores, there was no significant difference in satisfaction or expectation fulfillment. At 2 years, there was a no difference in satisfaction (85.7% in early vs 77.0% in late, $P = 0.275$) and expectation fulfillment (88.1% in early vs 75.4% in late, $P = 0.110$) in between the 2 groups (Table 4).

The early RTW group had a greater proportion of patients that returned to full functioning ($P = 0.046$) and returned to work without limitations ($P = 0.001$) at 6 months. However, similar proportions eventually

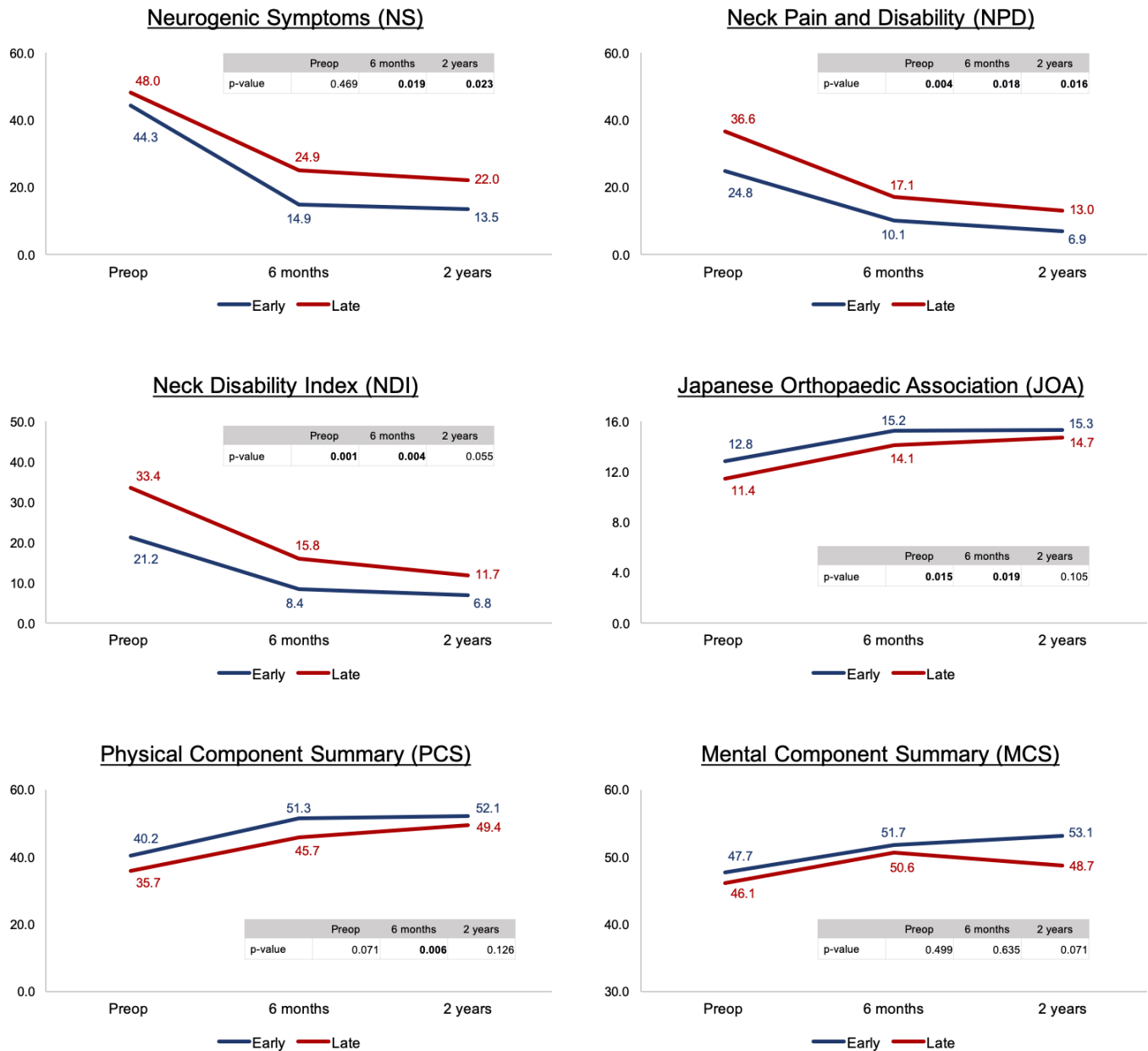


Figure. Patient-reported outcome measures at different time intervals.

returned to work by 2 years postoperatively ($P = 0.414$) (Table 5).

DISCUSSION

The socioeconomic burden of spinal disorders is increasing. When taking into account the frequency and cost of injury, spine-related conditions were one of the most expensive injury types due to their negative effect on work attendance and productivity.²¹ In this study, working adults who returned to work early after ACDF had better preoperative functional outcomes. However, all patients, regardless of the time taken to RTW, may benefit from surgical intervention

for DCM. Clinically meaningful improvements in functional and quality of life outcomes were achieved at 6 months and sustained at 2 years postoperatively, even in patients that returned to work later, and the degree of improvement was comparable. High rates of satisfaction and expectation fulfillment were also achieved in both groups. However, the follow-up JOA, NS, NPD, NDI, and PCS remained significantly lower in the late RTW group likely due to significantly lower baseline scores. Despite the delay in RTW at 6 months, this difference resolved at 2 years and a high overall rate of RTW was achieved in our study population of non-WC working adults, suggesting that

Table 3. Comparison of clinical outcomes between groups at different time intervals ($n = 103$).

	Early ($n = 42$)		Late ($n = 61$)		<i>P</i> Value ^a
	Mean	SD	Mean	SD	
6-mo VAS NP ^b	1.0	1.9	1.5	2.6	0.023
6-mo VAS AP ^b	0.3	1.2	0.9	1.9	0.027
6-mo JOA	15.2	1.9	14.1	2.6	0.022
6-mo NS ^b	14.9	15.1	24.9	24.1	0.044
6-mo NPD ^b	10.1	12.9	17.1	15.5	0.042
6-mo NDI ^b	8.4	12.0	15.8	13.2	0.074
6-mo PCS	51.3	8.5	45.7	10.8	0.059
6-mo MCS	51.7	10.6	50.6	11.7	0.015
2-y VAS NP ^b	0.6	1.9	1.1	2.3	0.325
2-y VAS AP ^b	0.3	1.0	1.2	2.6	0.060
2-y JOA	15.3	1.5	14.7	2.3	0.007
2-y NS ^b	13.5	14.3	22.0	20.6	0.046
2-y NPD ^b	6.9	10.0	13.0	13.7	0.042
2-y NDI ^b	6.8	10.2	11.7	13.8	0.036
2-y PCS	52.1	6.9	49.4	9.8	0.008
2-y MCS	53.1	9.8	48.7	13.5	0.057

Boldface indicates statistical significance.

^aUsing multivariate regression to control for age, gender, body mass index, comorbidities and baseline JOA and NDI scores.

^bA lower score is better.

Abbreviations: JOA, Japanese Orthopaedic Association; MCS, Mental Component Summary; NDI, Neck Disability Index; NPD, neck pain and disability; NS, neurogenic symptoms; PCS, Physical Component Summary; RTW, return to work; VAS AM, visual analog scale arm pain; VAS NP, visual analog scale neck pain.

ACDF is an effective treatment for working adults with DCM.

Few studies have investigated the factors that predict RTW and the majority of these studies have focused primarily on patients in the WC setting.⁶⁻⁸ Faour et al performed a retrospective study analyzing subjects through a WC database and determined that age greater than 50 years, a diagnosis of degenerative disc disease, being out of work for greater than 6 months, psychological comorbidities, and opioid use were negative predictors of RTW status.⁷ In contrast, this study is one of the few analyzing RTW rates among non-WC patients

undergoing elective cervical spine surgery. This is significant, as the results of previously published literature utilizing data from WC patients may not be applicable to the general patient population with degenerative cervical spine disease, since WC patients have significantly more days off before returning to work²² and inferior clinical outcomes.⁹⁻¹¹ Tabaraee et al studied 352 patients undergoing ACDF and concluded that WC patients had inferior clinical improvement at 1 year and increased rates of revision and reoperation compared with non-WC patients.²³

In a non-WC setting, Lee et al found that gender was not a predictor of RTW, whereas a positive comorbidity status, smoking, short fusion, and cervical fusion were possible negative predictors of RTW. In addition, the authors highlighted that preoperative employment was the strongest predictor of RTW after spinal surgery. However, the authors examined a heterogeneous population of non-WC patients who underwent spinal surgery (cervical, thoracic, and lumbar).¹³ More recently, Kim et al found that having a labor intensive vs sedentary occupation, a diagnosis of disc herniation vs cervical stenosis, a history of CAD, a history of COPD, a higher ASA grade, patients undergoing cervical corpectomy vs laminectomy and fusion, and increased length of surgery were factors associated with a lower likelihood of RTW at 3 months after cervical spine surgery.¹⁴ However, this study also examined a heterogeneous population of non-WC patients who underwent different cervical procedures for different diagnoses, although this has been shown to yield different RTW rates. For instance, Faour et al showed that cervical fusion for degenerative disc disease was associated with lower rate of successful RTW status when compared to fusion

Table 4. Minimal clinically important difference (MCID) attainment, expectation fulfillment, and satisfaction at different time intervals ($n = 103$).

Variable	Early RTW ($n = 42$)	Late RTW ($n = 61$)	<i>P</i> Value
Comparison at 6 months, %			
Attained MCID for NP	31.0	44.3	0.173
Attained MCID for AP	40.5	31.1	0.329
Attained MCID for JOA	71.4	70.5	0.918
Attained MCID for NDI	50.0	68.9	0.054
Attained MCID for PCS	61.9	63.9	0.834
Expectation fulfilled	85.7	73.8	0.146
Satisfied	88.1	83.6	0.526
Comparison at 2 years, %			
Attained MCID for NP	40.5	42.6	0.828
Attained MCID for AP	40.5	27.9	0.181
Attained MCID for JOA	64.3	78.7	0.106
Attained MCID for NDI	54.8	72.1	0.069
Attained MCID for PCS	66.7	68.9	0.815
Expectation fulfilled	88.1	75.4	0.110
Satisfied	85.7	77.0	0.275

Abbreviations: JOA, Japanese Orthopaedic Association; MCS, Mental Component Summary; NDI, Neck Disability Index; NPD, neck pain and disability; NS, neurogenic symptoms; PCS, Physical Component Summary; RTW, return to work.

Table 5. Return to work and return to function at different time intervals ($n = 103$).

Variable	Early RTW ($n = 42$)	Late RTW ($n = 61$)	<i>P</i> value
Comparison at 6 months, %			
Return to work			0.001
No	0	8.2	
Yes, with limitations	14.3	41.8	
Yes, with no limitations	85.7	50.0	
Return to function	64.3	44.3	0.046
Comparison at 2 years, %			
Return to work			0.414
No	0	1.6	
Yes, with limitations	23.7	36.0	
Yes, with no limitations	76.3	64.0	
Return to Function	71.4	65.6	0.531

Boldface indicates statistical significance.

Abbreviation: RTW, return to work.

for radiculopathy.^{6,7} To our knowledge, this study is the first to examine RTW in a non-WC, working adult population undergoing ACDF for DCM. We observed that more severe myelopathy symptoms (as reflected by poorer JOA) and greater preoperative disability (as reflected by poorer NPD and NDI) were associated with a more difficult recovery and an increased time to RTW. This finding may be representative of patients with spinal pathology that delay or avoid surgical intervention, opting to tolerate chronic pain or disability in fear that surgery will cause them to lose their jobs, resulting in a gradual decline of function with an increased severity of symptoms, which may in turn affect RTW after surgery.

Depression and poorer mental function have also been associated with prolonged time to RTW in patients undergoing spine surgery. In the context of lumbar spine literature, Parker et al in a 2-year longitudinal cohort study found that of the 32 patients working before transforaminal lumbar interbody fusion, all 15 (100%) patients in the top half of Zung score (better depression score) RTW postoperatively, whereas only 11 (65%) patients in the bottom half did so ($P = 0.02$).²⁴ Depression has also been linked to poor postoperative RTW status among a cohort of WC patients undergoing lumbar fusion.⁵ In contrast, Goh et al recently found that poor baseline mental health did not delay or prohibit the ability to RTW at 6 months to 2 years after single-level ACDF for cervical spondylotic myelopathy.²⁵ Our study cohort had a low prevalence of depression in both early and late RTW groups. This reflects the relatively young working adult population in our study who were unlikely to have psychiatric disease or mental ailments. This may also explain the lack of difference in SF-36 MCS between the early and late RTW groups in our study.

While we observed that working adults with poorer preoperative function and delayed RTW had poorer postoperative outcomes at 2 years, when we examined the change in measures from one period to the next, patients with early or delayed RTW demonstrated a similar improvement in pain, function, and quality of life. The proportion of patients that had a change in scores that met the MCID was also comparable at 6 months and 2 years, suggesting that early RTW had no influence on clinical outcomes after ACDF. In recent decades, attempts have been made to better evaluate clinical outcomes of medical care from the patient's perspective.²⁶ As part of these efforts, patient satisfaction has emerged as a metric for evaluating the quality of clinical care.²⁷ To date, no studies have investigated the relationship between the time taken to RTW and subjective satisfaction in working adults undergoing ACDF. Interestingly, early RTW in our study did not translate to higher rates of satisfaction and expectation fulfillment in working adults at 6 months and 2 years. Conversely, late RTW did not lead to greater dissatisfaction. The above findings suggest that ACDF is capable of providing satisfactory outcomes for working adults with a spectrum of disease severity, enabling patients with better general health to RTW earlier, while allowing patients with poorer baseline function to achieve similar clinical improvement in the midterm. Moreover, early RTW did not appear to be a determinant of patient satisfaction up to 2 years postoperatively.

There are several strengths of this study. When compared to similar studies in the literature, this study represents one of the largest cohorts of working adults undergoing ACDF for DCM in a non-WC setting. In addition, the use of multiple different objective and subjective outcome measures allowed a comprehensive evaluation of the relationship between time taken to RTW and patient outcomes. Although posterior

approaches exist as alternatives to ACDF, we designed the study to focus specifically on patients undergoing ACDF for DCM to maintain a more homogenous and less confounded population. Patients with radiculopathy were excluded as these patients tend to have greater AP and better JOA scores, thus potentially confounding the analysis. Factors affecting RTW rates in these patients have also been studied previously.⁷ Lastly, all cases were performed in a single high-volume institution with standardized nursing and physiotherapy regimes.

Several limitations of this study must be noted. This was a retrospective review of a consecutive series of patients. However, the outcomes used in this study were prospectively collected in a spine registry as part of the normal scope of practice, likely eliminating any bias in terms of data collection as the data were systematically collected according to an established postoperative protocol. The type of work undertaken by our study cohort and the duration of preoperative sick leave were not analyzed, hence it is plausible that patients who were involved in heavy labor may require a longer time to RTW. However, this was not the focus of our study, as prior studies have already determined that younger age was significantly associated with returning to heavy-duty work after ACDF.²⁸ Instead, our study focused on the RTW of non-WC patients, who are less likely to be involved in heavy labor. Radiological parameters were also not recorded in this study. However, this has not been shown to influence patient-reported outcomes or satisfaction after ACDF.²⁹

CONCLUSION

In addition to the routine risks and benefits of surgery, surgeons should also counsel working adults with cervical myelopathy on the factors associated with RTW after ACDF. While working adults that RTW later tend to have poorer function preoperatively, surgeons may reassure them that they will likely experience the same degree of clinical improvement and level of satisfaction after surgery when compared to patients who RTW early.

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