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Adverse effects of frailty on the outcomes of surgery for degenerative cervical myelopathy: results from a prospective multicenter international data set of 757 patients

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OBJECTIVE The goal of this study was to determine the effect of the degree of frailty on long-term neurological and functional outcomes after surgery for degenerative cervical myelopathy (DCM).

METHODS A combined database of patients enrolled in the Cervical Spondylotic Myelopathy–North America and Cervical Spondylotic Myelopathy–International prospective international multicenter observational studies who underwent surgery for DCM was used as the source data. All patients underwent baseline and follow-up assessment at 2 years after surgery for functional, disability, and quality of life measurements (modified Japanese Orthopaedic Association [mJOA] scale, Neck Disability Index, SF-36 physical and mental component summary scores). Patients were separated into 4 groups according to their baseline modified frailty index 5-point scale score: not frail, pre-frail, frail, and severely frail. Differences among groups were analyzed at baseline and at 2 years after surgery, including change in scores (delta values) and the odds ratio of achieving the minimum clinically important difference (MCID) through univariate and multivariable logistic regression adjusting for age, approach, number of levels treated, and sex.

RESULTS A total of 757 patients (63% male) with a mean age of 56 (95% CI 55.5–57.2) years were included: 470 patients underwent an anterior approach, 310 had a posterior approach, and 23 had a combined anterior/posterior approach. A total of 50% (n = 378) of patients were classified as not frail, with 33% (n = 250) pre-frail, 13% (n = 101) frail, and 4% (n = 28) severely frail. The baseline mJOA score was significantly lower with increasing frailty (14.00 [95% CI 13.75–14.19] for not frail vs 9.71 [95% CI 9.01–10.42] for severely frail patients; $p < 0.05$), but the change at 2 years was not significantly different among all groups (2.43 [95% CI 2.16–2.71] for not frail vs 2.56 [95% CI 1.10–4.02] for severely frail). The SF-36 delta values were also not different among groups, but significantly worse at baseline with increasing frailty. The odds ratio of achieving MCID for mJOA was significantly higher in the not frail group (1.89 [95% CI 1.36–2.61]; $p < 0.05$) compared to the other frailty cohorts, which remained after adjusting for age, approach, levels treated, and sex. The odds ratio of achieving MCID for the SF-36 domains was similar among all frailty groups.

CONCLUSIONS Increasing frailty is associated with worse baseline functional and quality of life measures in patients undergoing surgery for DCM. Frailty does not affect the magnitude of improvement in outcome measures after surgery, but reduces the chance of achieving the MCID for functional impairment significantly. Preoperative frailty assessment

ABBREVIATIONS CSM-I = Cervical Spondylotic Myelopathy–International; CSM-NA = Cervical Spondylotic Myelopathy–North America; DCM = degenerative cervical myelopathy; MCID = minimum clinically important difference; MCS = mental component summary; mFI-5 = modified frailty index 5-point scale; mJOA = modified Japanese Orthopaedic Association; NSQIP = National Surgical Quality Improvement Program; PCS = physical component summary.

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can therefore help guide clinicians in managing expectations after surgery for DCM. Potentially modifiable factors should be optimized in frail patients preoperatively to enhance functional outcomes.

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KEYWORDS frailty; elderly; degenerative cervical myelopathy; surgery; outcomes

DEGENERATIVE cervical myelopathy (DCM) is a syndrome manifested by neurological deficits of gait, loss of dexterity, and sphincter disturbance that arises from progressive compression of the spinal cord in the cervical canal. The incidence increases with age, and due to the shift in population demographics, it has become the number one cause of adult spinal cord dysfunction worldwide.[1–4] The mainstay of treatment is decompressive surgery, which has been demonstrated to promote recovery in both functional and quality of life outcome measures.[5,6] As a growing (potentially reversible) cause of neurological disability in the developed world, the factors affecting the outcomes after surgery have been a source of intense focus in the literature. The level of preoperative impairment, duration of symptoms, imaging characteristics, and age have all been shown to affect the risk of complications and chance of recovery after surgery.[7,8] Given that surgery can result in serious adverse events (quadriparesis, worsening neurological disability, airway compromise), it is imperative that patient selection is appropriate and that the benefits are adequately balanced against the risk profile.

Given that DCM is predominantly a disease of middle-aged and elderly individuals, the effect of aging on the management decisions for this disease has become an area of clinical importance. Increasing age is negatively correlated with complications and outcomes after spine surgery, but there has been a recent shift in focus toward assessments of frailty as more reliable predictors of perioperative complications and outcomes.[9,10] For patients with DCM, the modified frailty index 5-point scale (mFI-5) has been shown to be nearly perfectly correlated to the 11-point frailty scale, and to be a more robust predictor of perioperative complications than age alone.[11] Other measures of frailty, such as preoperative atrophy and fatty infiltration of the cervical paraspinal muscles, have also been investigated,[12–14] but not specifically applied to a prospective cohort of patients with DCM. Therefore, the objective of this study was to determine the effect of frailty, as measured by the mFI-5, on the long-term functional impairment, disability, and quality of life recovery in a cohort of patients undergoing surgery for DCM. Our hypotheses are as follows: 1) increasing frailty is associated with a worse baseline functional and quality of life assessment; 2) frailty is inversely correlated with the long-term outcomes after surgery; and 3) after adjusting for age, number of surgically treated levels, sex, and approach, increasing frailty is associated with lower odds of achieving the minimum clinically important difference (MCID) for each outcome measure.

Methods

Source Data and Patient Population

The source data for the study were derived from patients enrolled in both the AO Spine Cervical Spondylotic Myelopathy–North America (CSM-NA) and Cervical Spondylotic Myelopathy–International (CSM-I) studies; these are prospective multicenter observational studies of adult patients who underwent surgery for DCM. A total of 278 patients were recruited over 12 North American centers in the CSM-NA study, with an additional 479 patients recruited from 6 Asian, 5 European, 3 Latin American, and 2 North American centers in the CSM-I study. Inclusion criteria was identical for both studies, as follows: 1) symptomatic DCM with one or more clinical signs of myelopathy; 2) imaging evidence compatible with spinal cord compression; 3) age 18 years or older; and 4) no previous history of cervical spine procedures. Asymptomatic patients were excluded, together with patients with malignancy or metastatic disease, active systemic infection, trauma, rheumatoid arthritis (or other inflammatory disease such as ankylosing spondylitis), or symptomatic tandem lumbar stenosis. All patients underwent surgical treatment, with the approach and number of levels at the surgeon's discretion. Ethics approval for enrollment in the CSM-NA and CSM-I studies was obtained at each center involved in these studies. Research ethics board approval for the main coordinating center (University Health Network) was obtained for the current secondary analysis of these data sets.

Baseline Characteristics

General descriptive demographic data (age, race, smoking status) for all patients were recorded prior to surgery, with a focused myelopathy history including duration of symptoms, pathophysiology (i.e., presence of ossified posterior longitudinal ligament), and clinical signs present. Surgical approach, number of levels, and choice of procedure (anterior, posterior, combined, with or without fusion) was recorded. Surgical complications were reported up to 2 years after surgery.

Outcome Measures and Frailty Assessment

All enrolled patients underwent rigorous preoperative assessment in functional myelopathy impairment (modified Japanese Orthopaedic Association [mJOA] scale), disability (Nurick grade), and standardized quality of life measures (SF-36 mental component summary [MCS] and SF-36 physical component summary [PCS]). Outcome measures were then repeated at 24-month intervals after surgery.

Frailty was assessed for all patients using the mFI-5. This was calculated based on a cumulative score from 0 to 5, scoring 1 point for each of the following factors recorded in the preoperative enrollment questionnaire: functional dependence, diabetes, history of chronic obstructive pulmonary disease, hypertension, and history of congestive heart failure. Patients were classified by their scores into groups according to previously established catego-

ries: 0 as not frail, 1 as pre-frail, 2 as frail, and 3 or higher as severely frail.

Statistical Analysis and MCID

All statistical analyses were undertaken using the Stata 15 program (StataCorp) with an a priori specified significance level (2-tailed where applicable) of $p < 0.05$. Baseline descriptive statistics are reported as means and 95% CIs for continuous variables, and as count and percentage for categorical variables. One-way ANOVA was used to detect differences in scale variables between groups with normal distributions, with the Kruskal-Wallis test used for nonparametric distributions. Where applicable, the severely frail group was compared to the not frail group using the Student t-test to assess for significant differences in the change in outcome scores from baseline to 2 years. Achieving the MCID was recorded as a binary outcome for each patient, using previously reported descriptors and standards for MCID in patients with DCM for mJOA, SF-36 MCS, and SF-36 PCS scores (an established MCID has not been described for the Nurick grade). The odds of achieving the MCID at 2 years was then calculated as odds ratios with 95% CIs by using univariate linear regression models. This was also performed as multivariable models adjusting for age, surgical approach, sex, and number of levels treated.

Results

A total of 757 patients with complete follow-up from baseline to 2 years were included. The mean age of all patients was 56 (95% CI 55.5–57.2) years, with 63% (n = 475) male. A worsening degree of frailty was correlated with increasing mean age ($p < 0.001$). Patients in the frail and severely frail groups were significantly older than those in the not frail or pre-frail groups ($p < 0.001$). The degree of frailty was not associated with the duration of symptoms prior to surgery ($p = 0.64$). The majority of patients underwent anterior decompression (n = 470) with a discectomy, corpectomy, or a hybrid construct (Table 1). A total of 310 patients underwent posterior decompression, with laminectomy and fusion being the most common procedure (n = 209). The mean mFI-5 score for all patients was 0.71 (95% CI 0.65–0.77), with 83% of included patients in the not frail or pre-frail groups, 13% in the frail group, and 4% in the severely frail group.

The mean mJOA scores at baseline were significantly lower in the frail (11.03) and severely frail (9.71) groups compared to the not frail group (14; $p < 0.001$; Table 2). The SF-36 PCS and MCS scores were also progressively lower as the degree of frailty increased ($p < 0.001$ in both instances), with an increase in the Nurick grade correlating with an increase in the severity of frailty ($p < 0.001$). At 2 years, all frailty groups demonstrated an improved mean score in mJOA, Nurick grade, and PCS/MCS scores. The change in value from baseline at 2 years (delta value) was similar among all grades of frailty in terms of functional impairment (mJOA scale; $p = 0.24$; Table 3). The delta value for the SF-36 PCS score was lower in the severely frail group compared to the other groups (1.34 vs 5.53, 5.60, and 7.66), but this was not significantly different (using ANOVA to compare all groups, or t-test to compare the not frail and severely frail groups in isolation; $p = 0.10$, $p = 0.057$). The SF-36 MCS delta value was equivalent among all groups. The delta value for Nurick grade was different among groups ($p = 0.009$), with the severely frail group (0.72) significantly lower than the not frail group (1.33; $p = 0.03$).

Being in the not frail group was a significant predictor of achieving the MCID for the mJOA score at 2 years, but not for the SF-36 PCS or SF-36 MCS scores (Table 4). The

TABLE 1. Demographics of 757 patients with DCM

Characteristic	Value
Sex	
Male	475 (63%)
Female	282 (37%)
Mean age in yrs	56.00 [55.50–57.20]
Not frail	53.60 [52.55–54.80]*
Pre-frail	56.54 [55.04–58.03]*
Frail	62.90 [60.90–64.90]*
Severely frail	67.21 [63.45–70.98]*
Comorbidities	
Diabetes	60 (8%)
Cardiovascular disease	337 (45%)
Pulmonary disease	80 (11%)
Psychiatric disease	104 (14%)
Neurological disease	47 (6%)
Smoker	203 (27%)
Mean BMI	27.2 [26.9–27.7]
Mean duration of symptoms in mos	
Not frail	26.12 [22.32–30.00]
Pre-frail	27.61 [22.03–33.20]
Frail	28.06 [21.77–34.36]
Severely frail	18.14 [11.41–24.88]
Anterior approach, total	470
Discectomy	449
Corpectomy	103
Hybrid	88
Posterior approach, total	310
Laminectomy alone	22
Laminectomy + fusion	209
Laminoplasty	100
Combined, total	23
mFI-5	
Mean	0.71 [0.65–0.77]
Median	1
Not frail	378 (50%)
Pre-frail	250 (33%)
Frail	101 (13%)
Severely frail	28 (4%)

Values are expressed as the number of patients (%) or the mean [95% CI].
* Statistically significant differences ($p < 0.05$) between groups when assessed with 1-way ANOVA.

TABLE 2. Functional impairment and quality of life outcome measures for all patients by frailty group at baseline and at the 2-year postoperative interval

	mJOA		SF-36 PCS		SF-36 MCS		Nurick Grade	
	Baseline	2 Yrs	Baseline	2 Yrs	Baseline	2 Yrs	Baseline	2 Yrs
Not frail	14.00 [13.75–14.19]*	16.38 [16.17–16.60]*	37.00 [36.01–38.00]*	42.57 [41.44–43.71]*	42.41 [41.01–43.77]*	47.21 [45.85–48.57]*	2.52 [2.46–2.59]*	1.18 [1.04–1.32]*
Pre-frail	11.54 [11.18–11.90]*	14.60 [14.21–15.00]*	33.06 [32.00–34.17]*	38.54 [37.13–39.94]*	38.72 [37.00–40.45]*	44.57 [42.77–46.38]*	3.84 [3.69–3.98]*	2.18 [1.96–2.40]*
Frail	11.03 [10.55–11.51]*	13.68 [13.14–14.21]*	29.89 [28.41–31.35]*	37.36 [35.22–39.49]*	37.50 [34.87–40.12]*	45.39 [42.41–48.36]*	4.14 [3.94–4.35]*	2.74 [2.39–3.10]*
Severely frail	9.71 [9.01–10.42]*	12.32 [11.09–13.54]*	27.06 [25.04–29.07]*	28.28 [24.10–32.47]*	34.80 [29.22–40.38]*	41.33 [35.35–47.03]*	4.35 [4.14–4.57]*	3.60 [2.90–4.30]*

Values are expressed as the mean [95% CI].
* Statistically significant differences ($p < 0.001$) between groups using 1-way ANOVA or Kruskal-Wallis tests for nonparametric distributions.

pre-frail, frail, and severely frail groups demonstrated a progressively worse chance of achieving the MCID for the mJOA score. For the SF-36 PCS and SF-36 MCS outcome measures, being in the frail group showed a significantly positive improvement in the MCS category, but all other groups failed to show any significant predictive value. The predictive value for achieving MCID for the mJOA score in all groups and MCID for SF-36 MCS scores in the frail group remained significant after the mixed-effects multivariable modeling was applied (Table 5).

Discussion

Age-related degenerative diseases such as DCM are increasing in prevalence in the elderly population. Delivering safe and effective surgical care to an increasingly aging DCM population is a key public health priority, and understanding the key elements that contribute to the risks of surgery is a vital component to this paradigm. Although age undoubtedly has a large influence on the outcomes of patients after surgery for DCM, frailty has been demonstrated to be a more accurate predictor of perioperative risk compared to age alone.[11,15] This study represents the first description of the influence of frailty on long-term functional and quality of life outcomes after surgery for DCM. Increasing frailty appears to be associated with a worse baseline functional and quality of life impairment. Frailty does not affect the magnitude of improvement in functional impairment scores at 2 years, but the odds of achieving MCID are significantly reduced with an increasing degree of frailty. Severely frail patients do not show an improvement in the SF-36 PCS, but frail and severely frail patients show the greatest benefit after surgery in the SF-36 MCS.

Understanding the predictors of perioperative risks or functional outcomes after surgery has been the goal of extensive studies in the last 20 years, and frailty has been increasingly incorporated into risk-prediction models of spine surgery.[9,11,16,17] Many measures of frailty exist, including disease-specific assessments such as the adult spinal deformity frailty index (ASD-FI), but the mFI-11 (or the mFI-5) is most commonly applied in the spine literature.[9,18] Recent investigations have also used the cross-sectional area of paraspinal muscles, or the degree of fatty infiltration, as a marker of sarcopenia/frailty and how that can be correlated to postoperative outcome measures.[12,14,19] The complex interplay between frailty and age is not well defined in the DCM population, but it has been established that older age at presentation is associated with worse baseline functional impairment and quality of life measurements for patients with DCM.[15,20] The current study demonstrates that increasing mean age was strongly correlated with worsening degree of frailty, which is congruent with previous studies.[11] Worsening degree of frailty was also demonstrated to be associated with worse baseline functional impairment, quality of life scores, and disability. Considering that more frail and/or older patients often have significant barriers in the diagnosis of DCM and have worse quality of life scores compared to younger cohorts for a host of pathologies besides spine disease, this finding is not unexpected. Interestingly, our study suggests

TABLE 3. Change in functional impairment and quality of life outcome measures from baseline to 2-year postoperative interval for each degree of frailty severity

	Change at 2 Yrs After Surgery; Delta Values			
	mJOA	SF-36 PCS	SF-36 MCS	Nurick Grade
Not frail	2.43 [2.16 to 2.71]	5.53 [4.44 to 6.61]	4.73 [3.27 to 6.19]	1.33 [1.20 to 1.48]*
Pre-frail	2.98 [2.56 to 3.40]	5.60 [4.12 to 7.04]	5.93 [4.15 to 7.72]	1.63 [1.42 to 1.85]*
Frail	2.61 [2.00 to 3.21]	7.66 [5.43 to 9.90]	7.31 [3.94 to 10.68]	1.34 [1.01 to 1.68]*
Severely frail	2.56 [1.10 to 4.02]	1.34 [–2.70 to 5.37]	6.02 [–1.35 to 13.39]	0.72 [0.02 to 1.50]*
p value	0.24	0.10	0.42	0.009

Values are expressed as the mean [95% CI].
* Statistically significant differences ($p < 0.001$) between groups using 1-way ANOVA or Kruskal-Wallis tests for nonparametric distributions.

that frailty does not affect the duration of symptoms prior to surgery, which may indicate that other socioeconomic factors are more important.[21]

Patients in all frailty cohorts demonstrated an improved functional impairment score at 2 years (as measured by the mJOA) compared to baseline. The mean scores at 2 years were significantly different among groups, with the severely frail group demonstrating the lowest mean score (12.32) and the not frail patients demonstrating the highest score (16.38; $p < 0.001$). However, the magnitude of improvement (delta value) was similar for all frailty cohorts (range 2.43–2.98, $p = 0.24$). The OR of achieving MCID therefore represents how the magnitude of improvement relates to the baseline functional impairment, with any element of frailty representing a much worse odds of achieving the MCID compared to the not frail group. This is an important conclusion from the current study, and has not been established previously in the literature.

The mFI-5/mFI-11 has been used to investigate frailty in cohorts of patients undergoing cervical spine surgery, principally as these indexes relate to predictors of perioperative complications. Zreik et al. in 2021 used the National Surgical Quality Improvement Program (NSQIP) database to analyze 23,754 patients undergoing anterior cervical discectomy and fusion (myelopathy/radiculopathy not specified).[22] The mFI-5 was found to be correlated with length of stay and readmission, but did not appear to predict the risk of perioperative complications with any greater accuracy than age or American Society of Anesthesiologists classification. In contrast, Shin et al. used the same database to demonstrate that the mFI-11 is a reliable predictor of perioperative complications in patients undergoing anterior and posterior cervical spine fusions (pathology not specified).[23] The only study to use the mFI-5/mFI-11 to predict perioperative complications specific to patients with DCM showed a strong predictive value for both systems with regard to mortality, major complication, or other metrics such as length of hospital stay.[11] For patients with DCM, the mFI-5 had an almost identical correlation to the mFI-11 and a model incorporating age, mFI-5, number of levels, approach, and sex was demonstrated to be strongly predictive of perioperative complications. However, given that the data for all these studies were sourced from the NSQIP database, no correlation to functional or quality of life outcomes was possible.

The current study demonstrated that worsening frailty was associated with worse baseline and 2-year scores with quality of life and the Nurick grade, but did not appear to affect the odds of achieving the MCID for MCS/PCS scores. No previous studies have measured the long-term outcomes related to frailty measured by the mFI-5 for DCM patients, but recent studies assessing sarcopenia of paraspinal muscle as a surrogate marker of frailty have been performed.[12] Pinter et al. investigated the association between sarcopenia of the bilateral cervical multifidus muscle in 99 patients undergoing posterior cervical decompression and fusion with 12-month follow-up.[12] Patients with worsening sarcopenia did not appear to have any difference in the baseline level of disability or quality of life scores compared to those without. This is in contrast to our study, which demonstrates that increasing frailty is associated with worse baseline quality of life and level of disability. This discrepancy is likely to be a reflection of the difference in frailty assessment and the fact that the mFI-5 has a broader scope in the definition of frailty compared to sarcopenia assessment on imag-

TABLE 4. Odds of each frailty group achieving the MCID for functional and quality of life measures

	OR of Achieving MCID		
	mJOA	SF-36 PCS	SF-36 MCS
Not frail	1.89 [1.36–2.61]*	1.11 [0.82–1.50]	0.74 [0.55–1.00]
Pre-frail	0.64 [0.44–092]*	0.89 [0.63–1.24]	1.29 [0.92–1.81]
Frail	0.43 [0.26–0.66]*	1.13 [0.71–1.83]	1.66 [1.03–2.68]*
Severely frail	0.22 [0.09–0.50]*	0.44 [0.18–1.07]	1.00 [0.43–2.34]

Values are expressed as the mean [95% CI]. Odds were calculated using univariate logistic regression analysis.
* Statistically significant result with a confidence level of $p < 0.05$.

TABLE 5. Odds of each frailty group achieving the MCID for functional and quality of life measures

	OR of Achieving MCID		
	mJOA	SF-36 PCS	SF-36 MCS
Not frail	1.67 [0.19–2.34]*	1.04 [0.76–1.43]	0.70 [0.51–0.96]
Pre-frail	0.68 [0.50–0.99]*	0.92 [0.65–1.23]	1.33 [0.94–1.87]
Frail	0.53 [0.32–0.88]*	1.27 [0.77–2.09]	1.79 [1.08–2.95]*
Severely frail	0.26 [0.11–0.61]*	0.51 [0.21–1.26]	1.28 [0.53–3.08]

Values are expressed as the mean [95% CI]. Odds were calculated using a mixed-effects multivariable logistic regression model with patient age, approach (anterior/posterior), number of levels treated, and sex as covariates.
* Statistically significant result with a confidence level of $p < 0.05$.

ing. Sarcopenia was also associated with worse postoperative pain scores, level of disability, and quality of life (i.e., PROMIS) measurements compared to patients without sarcopenia, which is consistent with the findings of the current study. Functional impairment (mJOA score) was not assessed. The magnitude of improvement in the Neck Disability Index was much greater in the nonsarcopenic group, which echoes the change in Nurick grade seen in the current study. Pinter et al. also found the delta values for the quality of life scores were significantly different in the more frail groups. These differences are difficult to compare, because our study incorporated both anterior and posterior approaches and the quality of life measurements are not directly related (PROMIS vs SF-36).

There are strengths and limitations to the current study. The CSM-I and CSM-NA prospectively collected data set represents one of the most complete cohorts of patients undergoing DCM surgery recruited from a number of centers worldwide. The heterogeneity of the enrolled patients serves to reduce the impact of hidden confounders and recall bias. The statistical approach is simple, involves no data transformation, and to reduce overfitting the multivariable analysis is limited to only 4 metrics that have been previously demonstrated to be strongly associated with outcomes after cervical spine surgery.[11] Parametric and nonparametric populations were addressed separately, and many of the statistical significance values were $p < 0.001$. Potential confounders include selection bias, given that these conclusions may only be applicable to a cohort of patients with DCM who are willing to be subjected to the rigors of a clinical study. Similarly, patients with significant frailty or coexisting comorbidities—including osteoporosis, or tobacco smokers—that excluded them from enrollment in the original clinical studies may not be represented. The mFI-5 is a popular assessment of frailty in spine surgery; however, it relies on a deficit accumulation model and was derived primarily from the NSQIP data set. Although its use is validated in patients with DCM, whether the mFI-5 serves as the most robust assessment of frailty in the DCM population remains to be investigated.[9,11] The current study will be the first to present the association of mFI-5 to longer-term outcomes after surgery for DCM, but clearly further work is required to determine the most accurate frailty assessment in this patient cohort. The current study does not address the potential for improving frailty prior to surgery in order to optimize the outcomes after surgery. Given the time frame in which most patients with DCM require surgery, it is difficult to determine if there is any role in preoperative optimization of frailty. However, the use of Enhanced Recovery After Surgery (ERAS) protocols may benefit patients with DCM who have mild to moderate functional impairment.[24,25]

Conclusions

Increasing frailty is associated with worse baseline and 2-year postoperative functional impairment, quality of life, and level of disability scores in patients undergoing DCM surgery. The magnitude of change in these values at 2 years is similar across frailty groups—aside from the Nurick grade, which was worse in severely frail patients. The odds of achieving the MCID for mJOA score significantly reduce with worsening frailty, but this is not true for PCS or MCS quality of life measures. We therefore recommend that an assessment of frailty be used as part of a comprehensive physical assessment when evaluating patients undergoing DCM surgery, and that patients can be counseled accordingly with regard to their long-term functional and quality of life expectations. Potentially modifiable factors should be optimized in frail patients preoperatively to enhance functional outcomes.

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Disclosures

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Author Contributions

Conception and design: Fehlings, Wilson, Vaccaro, Arnold. Acquisition of data: Fehlings, Wilson, Arnold, Bartels, Barbagallo. Analysis and interpretation of data: Fehlings, Wilson, Badhiwala, Arnold. Drafting the article: Wilson. Critically revising the article: Fehlings, Wilson, Badhiwala, Vaccaro, Arnold, Bartels, Barbagallo. Reviewed submitted version of manuscript: Fehlings, Wilson, Badhiwala, Vaccaro, Arnold, Bartels, Barbagallo. Approved the final version of the manuscript on behalf of all authors: Fehlings. Statistical analysis: Wilson, Moghaddamjou. Administrative/technical/material support: Fehlings, Wilson. Study supervision: Fehlings.

Supplemental Information

Previous Presentations

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