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The Influence of Surgical Intervention and Sagittal Alignment on Frailty in Adult Cervical Deformity

BACKGROUND: Frailty is a relatively new area of study for patients with cervical deformity (CD). As of yet, little is known of how operative intervention influences frailty status for patients with CD.

OBJECTIVE: To investigate drivers of postoperative frailty score and variables within the cervical deformity frailty index (CD-FI) algorithm that have the greatest capacity for change following surgery.

METHODS: Descriptive analysis of the cohort were performed, paired *t*-tests determined significant baseline to 1 yr improvements of factors comprising the CD-FI. Pearson bivariate correlations identified significant associations between postoperative changes in overall CD-FI score and CD-FI score components. Linear regression models determined the effect of successful surgical intervention on change in frailty score.

RESULTS: A total of 138 patients were included with baseline frailty scores of 0.44. Following surgery, mean 1-yr frailty score was 0.27. Of the CD-FI variables, 13/40 (32.5%) were able to improve with surgery. Frailty improvement was found to significantly correlate with baseline to 1-yr change in CBV, PI-LL, PT, and SVA C7-S1. HRQL CD-FI components reading, feeling tired, feeling exhausted, and driving were the greatest drivers of change in frailty. Linear regression analysis determined successful surgical intervention and feeling exhausted to be the greatest significant predictors of postoperative change in overall frailty score.

CONCLUSION: Complications, correction of sagittal alignment, and improving a patient's ability to read, drive, and chronic exhaustion can significantly influence postoperative frailty. This analysis is a step towards a greater understanding of the relationship between disability, frailty, and surgery in CD.

KEY WORDS: Adult cervical deformity, Frailty, Cervical deformity frailty index, Frailty drivers, Health-related quality of life, Surgical outcomes, Postoperative frailty, Sagittal alignment, Surgical intervention, Ames modifier

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Adult cervical deformity (CD) is a condition stemming from multiple potential etiologies, such as spondylosis, inflammatory arthroplasty, trauma, infection, iatrogenic, neoplastic, congenital, and neuromuscular pathologies.[1] Given the host of potential causes, surgical management of CD is exceptionally complex, frequently requiring multisegment fusions, osteotomies, and surgical approach, all of which can lead to long operative times.[2] However, noteworthy advances have been made in the treatment of cervical spinal deformity. With the improvements made to imaging, instrumentation, techniques used in the operating room, medication, and critical care, surgeons have been enabled to properly address deformities of various degrees.[2]

With modern advances to CD management, there has been a concomitant increase in the total volume of cervical spine procedures, as well as the number of procedures performed on older, comorbid patients.[3-5] Despite the recent advances, there remains a high rate of

ABBREVIATIONS: BMI, body mass index; **CD,** cervical deformity; **CD-FI,** cervical deformity frailty index; **CI,** Confidence interval; **CL,** cervical lordosis; **CCI,** Charlson Comorbidity Index; **CBVA,** chin-brow vertical angle; **Mjoa,** modified Japanese Orthopaedic Association; **NDI,** Neck Disability Index; **PI-LL,** pelvic incidence minus lumbar lordosis; **PT,** pelvic tilt; **SVA,** sagittal vertical axis; **TS-CL,** thoracic slope-cervical lordosis

complications in cervical spine surgery. In a prospective database of 78 adult CD patients, 44% had at least 1 complication and 24% had at least 1 major complication.[6] In patients who underwent 3-column osteotomy in the cervical spine, the complication rate was even greater (60%), and the reoperation rate was 33%.[7] These findings begat the need for a better system for risk stratification and identification of patients at risk for protracted recovery.

Frailty, a geriatric syndrome characterized by weakness and fatigue, transcends traditional descriptors such as age and comorbidity, to give a predictive value that reflects multisystem impairments associated with decreased physiological reserve for coping with normal age-related stressors.[3] Frailty has consistently been characterized in the literature as a strong predictor of adverse outcomes following spine surgery.[8-10] An adult cervical deformity frailty index (CD-FI) was recently introduced by Miller et al,[11] which demonstrated a significant association between increasing patient frailty and longer hospital stays, higher complication rates, and greater likelihood of nonhome discharge. However, little is known about the change in frailty status postsurgical intervention. In addition, the CD-FI relies on 40 discrete health deficits, 17 of which are derived from patient-reported outcome measures. There has been limited discussion on which of the 40 discrete health deficits have the greatest potential for change or are the primary drivers of postoperative change in frailty. This investigation aimed to determine the impact of corrective surgery on the CD-FI. We further aimed to identify the drivers of postoperative frailty score and to determine which variable were modifiable and nonmodifiable in response to surgical intervention.

METHODS

Study Inclusion Criteria

This study is a retrospective review of a prospective, multicenter database of CD patients enrolled from 2013 to 2018 at 13 spine surgery centers across the United States. Included patients had complete baseline and 1-yr frailty scores. CD was defined radiographically as any one of the following: cervical kyphosis (C2-C7 $>10^\circ$), coronal Cobb angle $>10^\circ$, C2-C7 sagittal vertical axis (SVA) $>$ 4 cm, thoracic slope-cervical lordosis mismatch (TS-CL) $>10^\circ$, or chin-brow vertical angle (CBVA) $>25^\circ$. Exclusion criteria was defined as spinal deformity of neuromuscular etiology and presence of active infection or malignancy. Institutional Review Board approval was obtained at each respective home institution; this study was deemed exempt because of the de-identified nature of the data. Informed patient consent was obtained prior to enrollment.

Data Collection

Patient demographic data included age, sex, race, and body mass index (BMI). Baseline comorbidities included a history of smoking, osteoporosis, and Charlson Comorbidity Index (CCI). Patient frailty status was assessed utilizing the previously published CD-FI. The CD-FI developed by Miller and colleagues[11] includes 40 binary variables (0 or 1), and the frailty score is calculated by the mean presence or absence of the variables (eg, specific comorbidities or HRQLs) divided by total possible variables (40), resulting in a score from 0 to 1. Scores of <0.2 are defined as not frail, 0.2 to 0.4 defined as frail, and >0.4 defined as severely frail.[11] Clinical outcome assessments utilized within the CD-FI included the modified Japanese Orthopaedic Association (mJOA) score, Neck Disability Index (NDI), Numeric Rating Scale, and Neck and Back pain (Table 1). CD-FI scores were obtained at baseline and 1-yr postoperative follow-up. Surgical data collected included number of levels fused, surgical approach, decompression type (discectomy, foraminectomy, corpectomy, and laminectomy), osteotomy type (incomplete/complete facet, Smith-Petersen Osteotomy, and opening/closing wedge). Perioperative complications related to surgical treatment were also recorded.

Full-length free-standing lateral spine radiographs (36-inch cassette) were obtained for all patients at baseline and 1-yr postop. Radiographs were analyzed using SpineView (ENSAM, Laboratory of Biomechanics, Paris, France) software according to validated and standardized measurement techniques previously described in the literature.[12,13] Global sagittal alignment parameters assessed included SVA (C7-S1 SVA: horizontal offset in millimeters of the C7 plumb line from the posterosuperior corner of S1) and C2-S1 SVA. Regional and cervical alignment were assessed using cervical kyphosis (CK: C2-C7 angle $>10^\circ$), T1 slope (T1S: angle subtended by superior T1 endplate and the horizontal), C2-C7 cervical lordosis (CL), T1 slope minus cervical lordosis (TS-CL), and C2-C7 SVA (cSVA). Spinopelvic radiographic parameters assessed included pelvic tilt (PT: angle between the vertical and a line from the bicoxofemoral axis to the midpoint of the sacral endplate) and pelvic incidence minus lumbar lordosis mismatch (PI-LL: mathematical difference between pelvic incidence and lumbar lordosis).

Statistical Analysis

All statistical analyses were performed using SPSS software (Version 23.0, IBM, Armonk, New York). Descriptive statistics were used to summarize baseline patient demographics, radiographic parameters, and surgical details. Independent *t*-tests were used to assess the association between complication occurrence and patient frailty scores at 1 yr. Paired *t*-tests evaluate significant changes in factors comprising the CD-FI from baseline to 1-yr postoperatively were determined via paired two-sample *t*-tests. Pearson product-moment correlation coefficients were used to describe associations between postoperative changes in total CD-FI score and individual CD-FI score components. Logistic regression analysis assessed the relationship between increasing frailty and postoperative complications, as well as postoperative complications in patients with no change or an increase in postoperative frailty. Forward stepwise

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TABLE 1. Health Variables and Cut Points for the Frailty Index

Current health deficits
Documented by physician
>3 Medical problems
Anxiety
Body mass index <18.5 or >30
Cancer
Cardiac disease
Cerebrovascular disease
Currently receiving disability benefits
Dementia
Depression
Diabetes
Liver disease
Lung disease
Neuromuscular disease
Osteoporosis
Pancreatic disease
Rheumatoid arthritis
Smoker
Vascular disease
Venous disease
Unsteady gait
Patient-reported (questionnaire, question no.)
Bladder incontinence
Bowel incontinence
Difficulty driving (NDI, 8)
Difficulty getting dressed (mJOA)
Difficulty reading (LSDI, 4)
Difficulty sleeping >6 h (LSDI, 9; SWAL-QOL, 9b/d)
Difficulty walking without assistive device (mJOA)
Feeling anxious or depressed most of the time (EQ-5D-3 L)
Feeling tired most of the time (SWAL-QOL, 9c)
Feeling weak most of the time (SWAL-QOL, 9a)
Feeling worn out/exhausted most of the time (SWAL-QOL, 9e)
General health <50 (EQ VAS)
Inability to concentrate (LSDI, 6)
Inability to do normal work/schoolwork/housework (NDI, 7)
Inability to engage in normal recreational activity (LSDI, 10)
Inability to lift heavy objects (LSDI, 3)
Inability to perform normal activities (EQ-5D-3 L)
Inability to walk (EQ-5D-3 L)
Leg weakness
Personal care dependency (LSDI, 2)

Reprinted from *World Neurosurgery*, 109, Miller EK et al, Assessment of a Novel Adult Cervical Deformity Frailty Index as a Component of Preoperative Risk Stratification, e800-e806, Copyright 2018,[11] with permission from Elsevier.

linear regression described the effect of successful surgical intervention on change in total and component frailty scores. Successful surgical intervention was defined as achieving the lowest Ames classification modifiers. The Ames CD classification system incorporates both radiographic and clinical assessments to give a comprehensive evaluation of patient status and has been validated by previous literature.[14-16] All statistical tests were 2-tailed, and $P < .05$ was set as the threshold for statistical significance.

TABLE 2. Baseline Patient Characteristics

Demographics and clinical comparisons	
Sample (n)	138
Age	60.9
Sex	61.5%
BMI	29.3
Charlson comorbidity index	0.92
Baseline frailty score	0.4286
Race	
White	91.6%
Black	4.9%
Hispanic	3.5%
Radiographic Details	
Cervical Lordosis	-6.1 ± 20.8
SVA C2-C7	39.8 ± 19.9
TS-CL	38.7 ± 18.8
CBVA	2.9 ± 8.2
SVA C7-S1	-6.1 ± 20.8
PI-LL	1.6 ± 17.6
PT	19.9 ± 11.5
Surgical Details	
Posterior approach only	48.4%
Anterior approach only	17.6%
Combined approach	34%
Mean anterior levels fused	3.4
mean posterior levels fused	9.0
Mean Op time:	489.4 min
Mean EBL	822.5 ccs

RESULTS

Baseline Demographics and Clinical Comparisons

Of 153 operative CD patients, 138 met inclusion criteria for this study. The mean age was 61.0 y/o, 61.5% were women, mean BMI was 29.9, 91.6% white, 4.9% black, 3.5% Hispanic, mean CCI was 1.208, and the mean baseline frailty score was 0.44 (Table 2).

Baseline Radiographic and Surgical Details

Baseline radiographic parameters were the following: CL (-6.1 ± 20.8), SVA C2-C7 (39.8 ± 19.9), TS-CL (38.7 ± 18.8), CBVA (2.9 ± 8.2), SVA C7-S1 (-6.1 ± 20.8), PI-LL (1.6 ± 17.6), and PT (19.9 ± 11.5) (Table 2). Surgical details: 48.4% posterior approach only, 34% combined approach, 17.6% anterior approach only; mean anterior levels fused: 3.4; mean posterior levels fused: 9.0; mean op time: 489.4 min; and mean EBL: 822.5 ccs (Table 2).

Clinical and Radiographic Change in Frailty 1-yr Postsurgical Intervention

Following surgical correction, mean 1-yr frailty score was improved to 0.27 ($P < .05$) (Table 3). Patients who experienced a minor intraoperative complication displayed significantly worse baseline to 1-yr frailty improvements ($\Delta 0.06$ vs $\Delta 0.15$,

TABLE 3. Change in Frailty Postsurgical Intervention and CD-FI Variables Able to Improve With Surgical Intervention

Variable	Change in 1 yr, significance
Frailty	0.27, $P < .001$
Variable	**Significance ($P < .05$)**
Unsteady gait	$P < .001$
Bladder issues	0.167
Weakness	0.001
Anxiety	$P < .001$
Bowel issues	0.073
Driving	0.002
Walking about	0.002
SWAL 9A (feeling weak)	0.005
SWAL 9B (sleep)	0.003
SWAL 9C (feeling tired)	0.049
SWAL 9E (feeling exhausted)	0.117
EQ5D VAS	0.195
Concentration	$P < .001$
Work	0.083
Recreation	$P < .001$
Lifting	0.417
Activity	0.002
Mobility	0.015
CSDI reading	0.423
EQ5D depression	$P < .001$

$P = .045$). Of the variables included in the CD-FI, significant improvements were observed in 13/40 (32.5%), postoperatively. These variables included weakness, bladder issues, impaired gait, EQ5D anxiety, mJOA lower extremity, SWAL 9A-E, NDI concentration, NDI recreation, EQ5D activity, and EQ5D mobility (all $P < .05$) (Table 3).

Clinical and Radiographic Correlation With Change in Frailty 1-yr Postsurgical Intervention

Pearson bivariate correlations determined frailty improvement was significantly correlated with baseline to 1-yr change in HRQL CD-FI components of CSDI Reading (R: 0.998), SWAL 9C (feeling tired) (R: 0.574), SWAL 9E (feeling exhausted) (R: 0.574), and NDI driving (R: 0.523) (all $P < .001$, Table 4). Radiographic measurements with the highest correlation with significantly improved frailty were CBVA (R: 0.876, $P = .022$), PI-LL (R: 0.358, $P = .001$), PT (R: 0.243, $P = .021$), and SVA C7-S1 (0.237, $P = .029$) (Table 5). A total of 29% of patients included in this analysis experienced a minor postoperative complication, whereas 20% experienced a major postoperative complication. In an analysis of the association between frailty and postoperative complications, increasing frailty was associated with greater odds of experiencing both minor and major complications (Table 6). In addition, patients who experienced no postoperative change in frailty or an increase in postoperative frailty were more likely to have experienced at least 1 major complication (Table 7).

TABLE 4. Correlation of Improvement in Frailty Index 1-yr Postsurgical Intervention

Variable	Pearson correlation	Significance ($P < .05$)
Unsteady gait	0.173	.077
Bladder issues	0.233	.016
Weakness	0.316	.001
Anxiety	0.434	$P < .001$
Bowel issues	0.051	.600
Driving	0.523	$P < .001$
Walking about	−0.416	$P < .001$
SWAL 9A (feeling weak)	−0.489	$P < .001$
SWAL 9B (sleep)	−0.507	$P < .001$
SWAL 9C (feeling tired)	−0.574	$P < .001$
SWAL 9E (feeling exhausted)	−0.574	$P < .001$
EQ5D VAS	−0.110	.280
Concentration	0.427	$P < .001$
Work	0.318	.001
Recreation	0.486	$P < .001$
Lifting	0.265	.007
Activity	0.421	$P < .001$
Mobility	0.316	.001
CSDI reading	−0.998	.045
EQ5D depression	0.434	$P < .001$

TABLE 5. Radiographic Drivers of Frailty Index Improvement and Linear Regression Analysis to Determine Predictors of Postoperative Change in Frailty 1-yr Postsurgical Intervention

Variable	Pearson correlation	Significance ($P < .05$)
Cervical lordosis	0.016	.880
SVA C2-C7	0.074	.469
TS-CL	0.071	.495
CBVA	−0.876	.022
SVA C7-S1	−0.237	.029
PI-LL	−0.358	.001
PT	−0.243	.021
Variable	**R^2**	**Significance ($P < .05$)**
Successful surgery	0.173	.036
Anxiety	0.052	.710
Driving	0.110	.261
SWAL 9A (Feeling weak)	0.08	.479
SWAL 9B (Sleep)	0.132	.147
SWAL 9C (Feeling tired)	0.082	.443
SWAL 9E (Feeling exhausted)	0.175	.042
EQ5D VAS	0.002	.99
Concentration	0.134	.116
Work	0.104	.272
Recreation	0.110	.229
Lifting	0.136	.111
Activity	0.082	.415
Mobility	0.058	.644
EQ5D depression	0.052	.710

TABLE 6. Regression Analysis of Increasing Frailty and Postoperative Complications

	Odds ratio	95% CI Lower bound	95% CI Upper bound	Significance
No complication	0.08	0.003	2.13	0.8
Minor complication	1.01	0.3	2.13	0.131
Major complication	2.71	0.88	3.6	0.56

TABLE 7. Regression Analysis of Patients With No Change or Increase in Postoperative Frailty and Postoperative Complications

	Odds ratio	95% CI Lower bound	95% CI Upper bound	Significance
No complication	1.9	0.79	4.6	0.15
Minor complication	0.79	0.35	1.82	0.58
Major complication	2.93	0.83	10.38	0.09

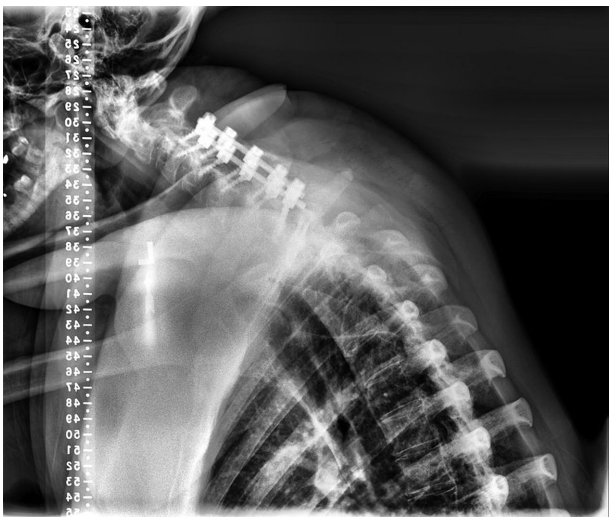

FIGURE 1. *Preoperative lateral radiograph case example of a severely frail patient. The baseline CD-FI score was 0.55.*

Case Example

Figure 1 presents a preoperative lateral cervical radiograph of a severely frail patient. The patient was a 42-yr-old female with a preoperative frailty score of 0.55. She had a baseline EQ5D score of 0.63. Her NDI concentration was 4, NDI driving score 5, NDI lifting score 4, NDI reading score 4, and NDI sleeping score 5, and her SWAL9 A-E scores were 2, 1, 1, 1, and 1. She underwent surgical correction of her CD, through posterior approach, pedicle subtraction osteotomy, with a UIV of C2 and

FIGURE 2. *Postoperative lateral radiograph of case example of a severely frail patient. The postoperative CD-FI was 0.45.*

LIV of T5. The patient was discharged from the hospital 8 d later. Figure 2 presents her lateral cervical radiograph at 1-yr postoperatively. One-year postoperatively, her NDI concentration decreased to 3, NDI reading decreased to 3, and her SWAL9 A-E increased to 3 s.

Her positive frailty components preoperatively were cancer, BMI, diabetes, weakness, number of comorbidities (2), anxiety, bowel issues, difficulty driving, difficulty getting dressed, walking about, feeling weak, trouble sleeping, feeling exhausted, feeling tired, difficulty concentrating, trouble working, trouble with recreation, lifting, activity, mobility, and EQ5D depression. Postoperatively, her positive frailty components were cancer, BMI, diabetes, weakness, number of comorbidities (2), driving, difficulty getting dressed, walking about, weakness, trouble sleeping, feeling exhausted, feeling tired, difficulty with work, recreation, lifting, activity, and mobility. Her overall 1-yr postoperative frailty score was 0.45.

Linear Regression Analysis

Linear regression analysis determined successful surgical intervention (as defined by lowest Ames deformity classification system) and SWAL 9E (feeling exhausted) were the variables with the greatest impact on postoperative change in overall frailty score (R^2: 0.173, $P = .036$ and R^2: 0.175, $P = .042$) (Table 5). Achieving deformity correction of TS-CL (Ames

modifier, no deformity) was a consistently strong individual predictor in all models (highest result β: 0.274 $P = .024$).

DISCUSSION

As the field of CD surgery continues to progress, the importance of being able to risk stratify and predict which patients will have successful outcomes will heighten. Recently, greater focus has been placed on utilizing frailty scores to more accurately risk stratify patients by developing novel frailty indices that are pathology specific, which correlate with postoperative patient outcomes.[10,17,18] Recent literature has demonstrated that higher frailty scores are significantly associated with higher complication rates, higher revision rates, and longer postoperative hospital stays.[19-21] However, the postoperative frailty of CD patients and the factors most associated with a decrease in frailty have not been well described. The purpose of this study was to quantify the total change in frailty observed in patients undergoing operative intervention and to identify the component variables most likely to drive improvement in postoperative frailty score. Our study identified the 13/40 variables in the CD-FI that were improved upon with surgical intervention as well as which variables were most predictive of a change in postoperative frailty scores.

Recently, the adult CD-FI developed by Miller et al[11] assesses frailty based on 40 health deficits. Example deficits include medical problems such as anxiety, body mass, cancer, cardiac disease, dementia, etc, and 17 patient-reported outcomes such as bladder incontinence, difficulty driving, feeling tired most of time, etc. The mean preoperative CD-FI of the cohort in this study was 0.44, corresponding to a severely frail score. The mean 1-yr postsurgical intervention CD-FI of the cohort was 0.27 ($P < .05$), with an average decrease of 0.15 ($P < .05$) for patients who experienced no complications. Rothrock et al[3] evaluated using frailty status to predict cognitive as well as functional outcomes; however, the investigation was limited to outcomes at 3 mo and included both cervical and lumbar patients. Although there is recent literature on HRQL improvement in adult spinal deformity patients,[22] there has been little longitudinal investigation into the cervical postoperative frailty drivers. This study was able to quantify the average change that occurs with surgery and had follow-up reaching 1 yr. This represents significant strides to expand the frailty index to better gauge postoperative health in CD patients.

Our study identified 20/40 component variables of the CD-FI that showed some improvement 1-yr postsurgery, 13/40 of those variables were able to significantly ($P < .05$) improve. Shin et al[19] discussed the use of a modified frailty index to predict postoperative complications and outcomes within 30 d of undergoing either anterior cervical discectomy and fusion or posterior cervical fusion. Predictors of complication were identified; however, the findings were not generalizable to the wider CD population, and there was no ability to identify postoperative change in frailty or the drivers responsible.

Of the 13/40 HRQL CD-FI components that were responsive to surgical intervention, CSDI reading (R: 0.998), SWAL 9C (feeling tired) (R: 0.574), SWAL 9E (feeling exhausted) (R: 0.574), and NDI driving (R: 0.523) were most strongly correlated with a change in the overall postoperative frailty score (all $P < .001$). The improvement in NDI driving and CSDI reading are likely secondary to increases in patient mobility after surgery. The feeling tired and feeling exhausted variables were also significant. This could be the result of improvement in global alignment and decreased energy expenditure required for normal gait and posture.[23] Patients who experienced complications were found to have smaller decreases in postoperative frailty than controls ($\Delta 0.06$ vs $\Delta 0.15$, $P = .045$), findings that were discussed in previous correlations of complications with postoperative outcomes scores.[24]

Linear regression analysis was used to determine the factors most associated with improvement in CD-FI. Our analysis showed that successful surgical intervention, achieving Ames modifier of no deformity (R^2: 0.173, $P = .036$), and SWAL 9E feeling exhausted (R^2: 0.175, $P = .042$) were the most predictive factors of improving postoperative frailty score. In addition, both models found achieving deformity correction of TS-CL as the strongest individual predictor of CD-FI improvement. TS-CL, a measure of the difference between T1 slope and CL, can be used to assess CD.[16] In the Ames deformity classification, a TS-CL of $<15^\circ$ is considered normal. Previous literature has shown that operative patients with primary cervical deformities experienced significant improvements in HRQL scores at 1 yr postoperatively with improvement in the Ames TS-CL modifier at a greater rate than patients whose operative levels did not include the primary driver of their deformity.[16] Of note, the Ames TS-CL takes into account the cervicothoracic junction and global deformity. Passias et al[25,26] have shown that failure to correct the C2-T3 angle is associated with malalignment following corrective surgery as well as a small positive correlation with post-op C2-T3 Lordosis, PT, and SVA. These findings underscore the importance of the relationship between the cervical and thoracolumbar spine, furthering the necessity for an accurate predictor of successful surgical intervention, as outcomes in one segment of the spine unequivocally affect the other.

Limitations

Several limitations are appreciated in this study. First, this database was the product of a multicenter collaboration. There may have been surgeon and site variation bias, as well as data entry errors. In addition, variation in radiographic positioning and protocols may have contributed to site differences. Finally, although the Ames criteria has been validated and accepted as a criteria of evaluating surgical outcomes in CD patients, there is no universal definition of a good surgical outcome. Despite these limitations, this study incorporated sites from across the continental United States, offering more generalizability of the findings

and was able to expand the clinical applicability of CD-FI and its use in predicting postoperative outcomes.

CONCLUSION

The CD-FI is an important tool in stratifying preoperative CD patients. This study quantified the improvement in postop frailty for CD-FI patients undergoing intervention. Summarily, restoration of optimal cervical alignment, and improving a patient's functional capacity, as measured by their ability to read, drive, and relieving chronic fatigue, can significantly contribute to reducing patient frailty.

Disclosures

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