

Does Frailty and other Predictors correlate with Late Mechanical Failure After Lumbar or Thoracolumbar Spinal Fusion for Adult Spinal Deformity: A Multivariable Analysis of 217 Consecutive Patients

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Introduction

Adult spinal deformity (ASD) surgery carries substantial risk of revision procedures, yet the role of frailty as a predictor remains controversial in regards of revision operations due to junctional failure. This study investigated whether preoperative frailty, measured by the Clinical Frailty Scale (CFS), predicts the risk of revision surgery and identified alternative predictors in a contemporary surgical cohort.

Materials and Methods

A retrospective analysis of 217 consecutive patients (mean age 67.0±10.2 years, 62.3% female) who underwent long-segment spinal fusion for ASD at a single tertiary center (2015-2023) was performed. Preoperative assessment included CFS, ASA score, comorbidities, bone mineral density and laboratory parameters. The primary outcome was the need for revision surgery in the follow-up period of at least 1 year.

Results

Overall, 80 patients (36.9%) underwent at least one revision surgery (Table 1). Contrary to our hypothesis, preoperative CFS showed no significant association with revision surgery (OR= 1.11, p=0.492). Further multivariate analysis identified significant predictors: ASA score (OR=2.75, p=0.002), osteoporosis/osteopenia (OR=2.1, p=0.016) as well as construct length (OR=0.88, p=0.025)(Table 2). Frailty significantly worsened between initial and revision surgery (mean increase +0.38 points, p=0.0002). Additionally, frailty showed significant correlations with 60-day complication rate (p=0.023).

Conclusion

Preoperative CFS alone is not a reliable predictor of late mechanical complications after ASD correction. Instead, frailty was significantly associated with early (60 days) postoperative non-surgical complications. The significant worsening of frailty after revision surgery suggests that frailty may be more of a consequence than a predictor of mechanical complications. ASA score, osteoporosis and shorter constructs were associated with significant higher revision risk. These findings implicate that frailty correlates with medical complications but cannot predict mechanical failure. Preoperative risk stratification in ASD surgery incorporating modifiable medical and radiological factors should guide surgical decision-making.

Table 1. Baseline Patient Characteristics

Characteristic	Total Value (n=217)	No Revision (n=137)	Revision (n=80)	p-value
Age (years) *	67.5 ± 9.3	67.6 ± 9.8	67.3 ± 8.6	0.621
Female sex	134 (61.8%)	89 (65.0%)	45 (56.2%)	0.259
BMI (kg/m²) *	27.7 ± 5.4	27.6 ± 5.1	27.8 ± 5.8	0.964
Active smoker	64 (29.5%)	41 (29.9%)	23 (28.7%)	0.977
Diabetes mellitus	43 (19.8%)	26 (19.0%)	17 (21.2%)	0.819
Osteoporosis/Osteopenia	48 (22.2%)	22 (16.1%)	26 (32.5%)	0.015
ASA Score				0.01
ASA I	6 (2.8%)	6 (4.4%)	0 (0%)	
ASA II	122 (56.2%)	84 (61.3%)	38 (47.5%)	
ASA III	89 (41.0%)	47 (34.3%)	42 (52.5%)	
Clinical Frailty Scale *	3.6 ± 1.1	3.5 ± 1.1	3.7 ± 1.1	0.285
Preop MCHC (g/L) *	339.62 ± 13.3	341.0 ± 12.4	337.1 ± 14.5	0.113
Preop MCV (fL) *	88.43 ± 5.8	88.6 ± 5.5	88.1 ± 6.4	0.629
Preop Hemoglobin (g/L) *	130.24 ± 21.5	132.0 ± 17.4	127.1 ± 27.1	0.42
LDH		215.6 ± 55.4	225.4 ± 58.5	0.301
Total Protein		6.5 ± 1.0	6.6 ± 1.0	0.265

* mean ± SD; residual values are given in: n (%)

Table 2 Multivariate Analysis

Variable	Odds Ratio (OR)	95% CI	p-value
Clinical Frailty Scale	1.11	0.83 – 1.47	0.492
Age	0.97	0.94 – 1.00	0.086
ASA Score	2.75	1.47 – 5.14	0.002
Osteoporosis/Osteopenia	2.10	1.15 – 3.85	0.016
Levels (amount)	0.88	0.78 – 0.98	0.025
Operative time (min)	1.00	0.99 – 1.01	0.30
BMI	0.98	0.92 – 1.04	0.43