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# The patient demographics, radiographic index and surgical invasiveness for mechanical failure (PRISM) model established for adult spinal deformity surgery

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# Purpose

to establish risk stratification index for MF based on baseline demographic, radiographic, and surgical invasiveness data in a retrospective case series.

# Methods

- Uni- and multivariate logistic regression analysis were performed to identify the independent risk factor for MF.
- Each risk factor identified by multivariate analyses was assigned a value based on its regression coefficient, and the values of all risk factors were summed to obtain the risks stratification score.
- Clinically important variables were add-on to improve the accuracy of the index.

## **Demographic and clinical data;**

Age, gender, BMI, BMD, history of spine & joint surgery, frailty (mFI), and comorbidities (CCI)

## **Surgical data;**

SRS-Schwab ASD type, PSO, LIF, UIV and LIV levels, no. of fused vertebrae, rod materials, and no. of connectors (rod diameter; 5.5mm only).

# Univariate risk analysis for MF following ASD surgery

	Regression coefficient	P value	OR		Regression coefficient	P value	OR
<b>Age</b>				<b>SRS-Schwab class</b>			
< 60yrs		Reference		Type T		Reference	
> 60yrs	1.33 (0.27)	<.01*	3.79 [2.23, 6.44]	Type D	1.55 (0.49)	<.01*	4.71 [1.80, 12.29]
<b>BMI (p for trend)</b>	0.93 (0.23)	<.01*	2.54 [1.63, 3.98]	Type L	1.75 (0.50)	<.01*	5.77 [2.17, 15.31]
Lean		Reference		Type N	2.71 (0.52)	<.01*	15.00 [5.39, 41.71]
Moderate	0.95 (0.35)	<.01*	2.59 [1.30, 5.18]	<b>Sagittal modifier</b>			
Overweight	1.87 (0.46)	<.01*	6.46 [2.63, 15.84]	<b>IL (p for trend)</b>	0.95 (0.18)	<.01*	3.37 [2.35, 4.84]
<b>BMD</b>				IL (0)		Reference	
T-score > -1.5		Reference		IL (+)	0.75 (0.48)	.12	2.12 [0.83, 5.41]
T-score $\leq$ -1.5	1.51 (0.23)	<.01*	4.50 [2.44, 8.31]	IL (++)	1.86 (0.36)	<.01*	6.43 [3.19, 12.97]
<b>Frailty (p for trend)</b>	1.29 (0.24)	<.01*	3.62 [2.26, 5.81]	<b>PT (p for trend)</b>	1.33 (0.27)	<.01*	3.79 [2.23, 6.44]
Robust		Reference		PT (0)		Reference	
Prefrail	1.49 (0.30)	<.01*	4.44 [2.47, 8.00]	PT (+)	1.53 (0.40)	<.01*	4.61 [2.11, 10.10]
Frail	2.08 (0.60)	<.01*	8.00 [2.45, 26.10]	PT (++)	2.51 (0.39)	<.01*	12.30 [5.74, 26.35]
<b>THA</b>				<b>SVA (p for trend)</b>	0.90 (0.17)	<.01*	2.45 [1.76, 3.41]
No THA		Reference		SVA (0)		Reference	
THA	1.13 (0.63)	.07	3.10 [0.91, 10.59]	SVA (+)	1.35 (0.32)	<.01*	3.86 [2.05, 7.27]
				SVA (++)	1.74 (0.34)	<.01*	5.70 [2.92, 11.11]
				<b>GAP score</b>	0.15 (0.17)	.39	1.16 [0.83, 1.64]
				PR		Reference	
				MD	-0.48 (0.35)	.17	0.62 [0.31, 1.23]
				SD	0.14 (0.35)	.69	1.15 [0.58, 2.38]

# Univariate risk analysis for MF following ASD surgery

	Regression coefficient	P value	OR
<b>UIV</b>			
Above T8		Reference	
Below T9	0.94 (0.27)	<.01*	2.57 [1.51, 4.36]
<b>LIV</b>			
Above L5		Reference	
Pelvis	1.69 (0.28)	<.01*	5.39 [3.12, 9.31]
<b>Revision surgery</b>	0.13 (0.52)	.80	1.14 [0.41, 3.15]
<b>LIF</b>	0.76 (0.35)	.03*	2.15 [1.08, 4.28]
<b>PSO</b>	1.07 (0.44)	.01*	2.91 [1.23, 6.87]
<b>Rod materials</b>			
Ti alloy		Reference	
CoCr	-0.20 (0.26)	.44	0.82 [0.50, 1.35]
<b>No. of connectors (p for trend)</b>	-0.28 (0.19)	.13	0.76 [0.52, 1.09]
0		Reference	
1	-0.22 (0.39)	.72	0.87 [0.40, 1.87]
2	-0.51 (0.39)	.21	0.60 [0.28, 1.32]

## Multivariate analysis

Forced entry (p<.05);

- ✓ Age,
- ✓ BMI,
- ✓ BMD,
- ✓ PT,
- ✓ PI-LL,
- ✓ SVA,
- ✓ Frailty,
- ✓ LIF,
- ✓ PSO,
- ✓ UIV and LIV

# Multivariate risk analysis of MF

	<b>Regression coefficient</b>	<b>P value</b>	<b>OR</b>
<b>BMD (T score &lt;-1.5)</b>	1.33 (0.36)	<.01*	3.79 [1.88, 7.66]
<b>BMI (category)</b>	0.54 (0.27)	.04*	1.72 [1.02, 2.92]
<b>Frailty</b>	0.64 (0.27)	.02*	1.89 [1.12, 3.21]
<b>Subcategory: PT</b>	0.97 (0.21)	<.01*	2.63 [1.76, 3.93]

SE in parenthesis. 95%CI in bracket. \*statistically significant.

# Risk stratification index based on the regression coefficient of univariate LRA

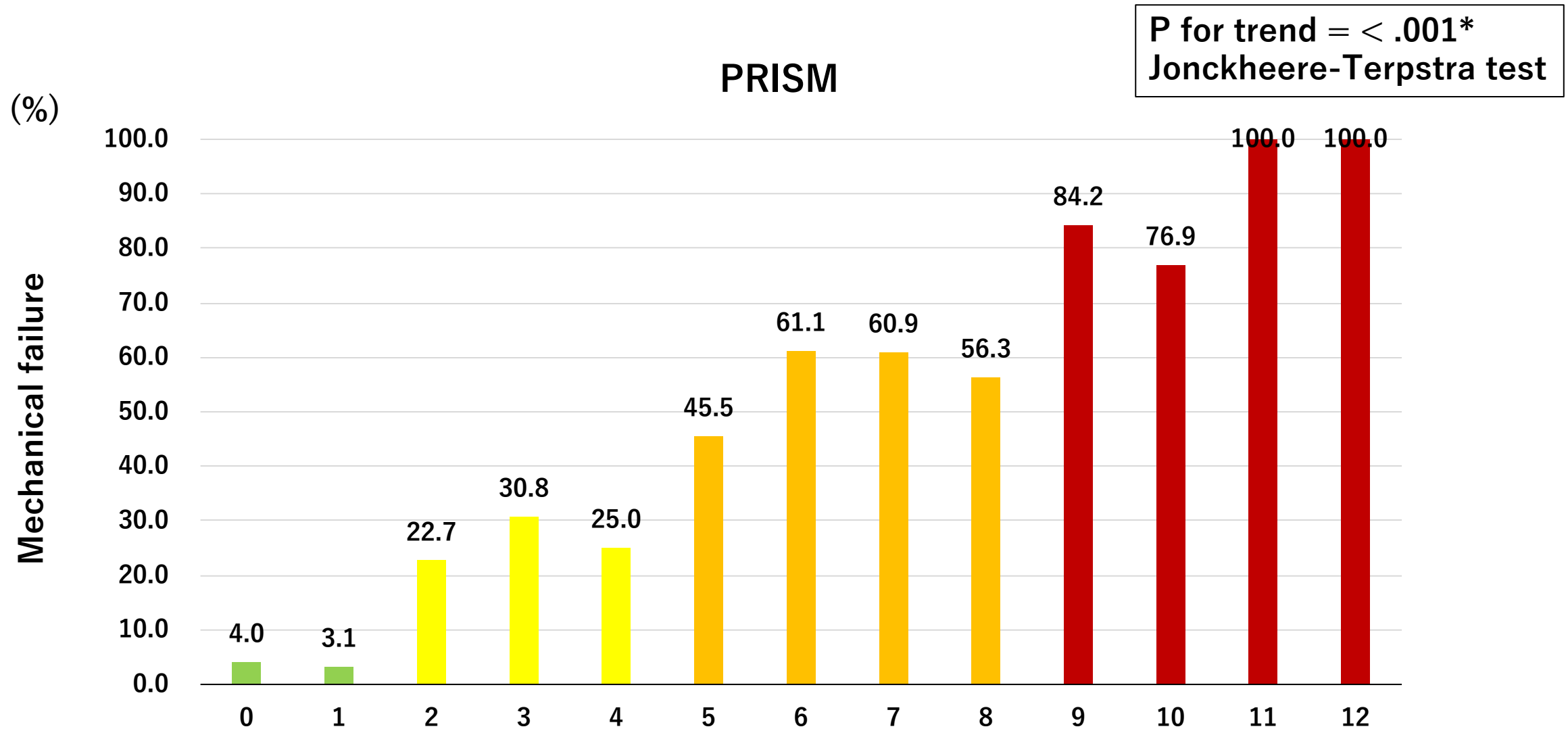
	Regression coefficient	P value	OR	weight
BMI (Lean)				0
BMI (Moderate)	0.95 (0.35)	<.01*	2.59 [1.30, 5.18]	1
BMI (Overweight)	1.87 (0.46)	<.01*	6.46 [2.63, 15.84]	2
BMD (T score > -1.5)				0
BMD (T score $\leq$ -1.5)	1.51 (0.31)	<.01*	4.51 [2.44, 8.31]	2
PT (0)				0
PT (+)	1.53 (0.40)	<.01*	4.61 [2.11, 10.10]	2
PT (++)	2.51 (0.39)	<.01*	12.30 [5.74, 26.35]	3
Frailty (robust)				0
Frailty (prefrail)	1.49 (0.30)	<.01*	4.44 [2.47, 8.00]	1
Frailty (frail)	2.08 (0.60)	<.01*	8.00 [2.45, 26.10]	2
LIV (above L5)				0
LIV (pelvis)	1.69 (0.28)	<.01*	5.39 [3.12, 9.32]	2
Age (< 60yrs)				0
Age ( $\geq$ 60yrs)	1.33 (0.27)	<.01*	3.79 [2.23, 6.44]	1



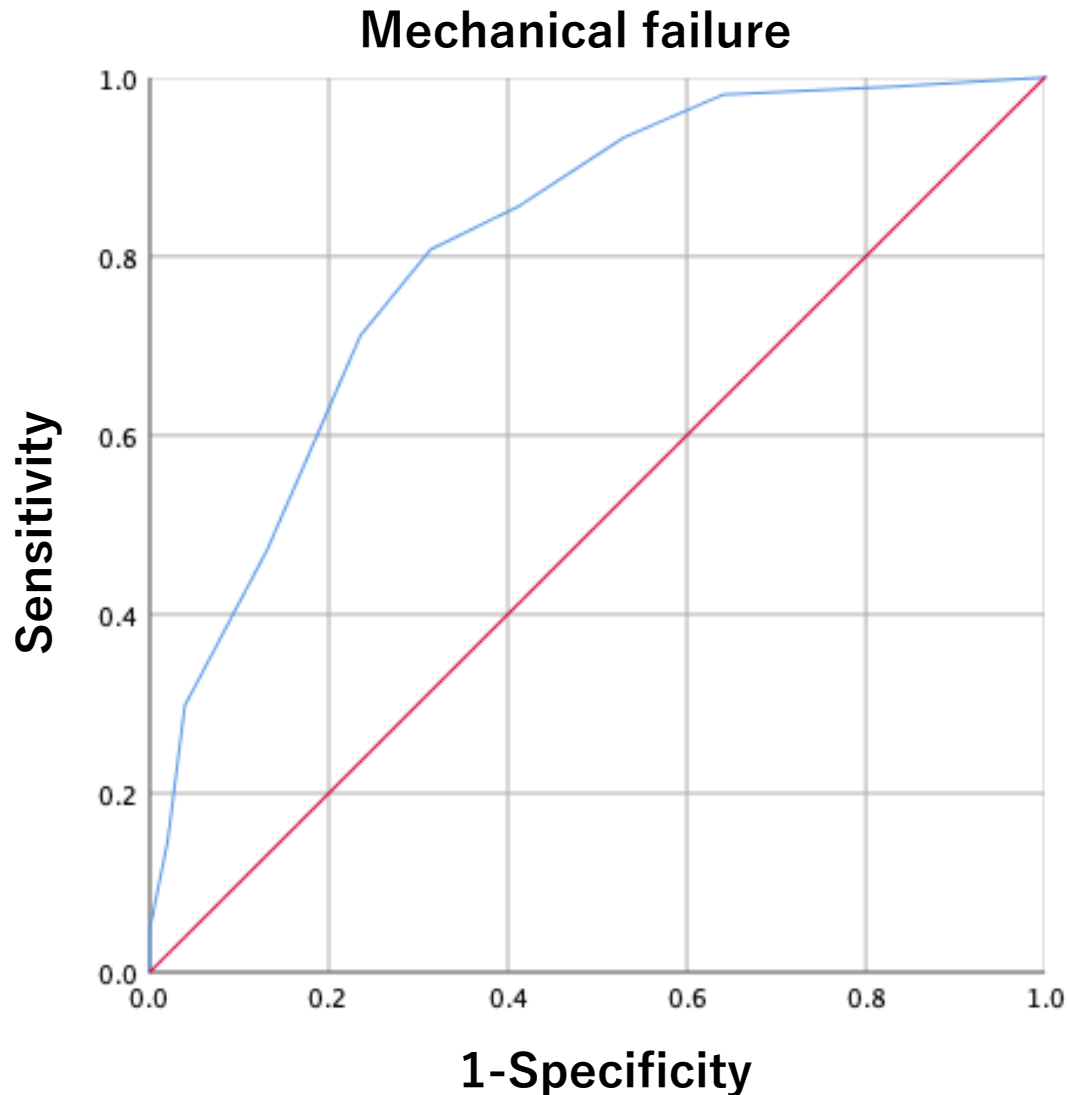
# PRISM (Patient demographic and radiographic index and surgical invasiveness for mechanical failure)

	Score	Grade
<b>Age</b>		
< 60yrs	0	Total score: 0 - 1 Low risk
≥ 60yrs	1	
<b>BMD (T-score)</b>		
≥ -1.5	0	Total score: 2 - 4 Moderate
< -1.5	2	
<b>BMI</b>		
< 18.5kg/m <sup>2</sup>	0	Total score: 5 - 8 high
18.5 - 25kg/m <sup>2</sup>	1	
> 25kg/m <sup>2</sup>	2	
<b>Frailty</b>		
Robust	0	Total score: 8 - 12 Very high
Prefrail	1	
Frail	2	
<b>LIV</b>		
Above L5	0	
Pelvis	2	
<b>PT</b>		
< 20°	0	
20 - 30°	2	
> 30°	3	

# Trend analysis of PRISM and MF



# Sensitivity analysis of PRISM



Cutoff value	Sensitivity	1 - Specificity
-1.00	1.000	1.000
0.50	0.990	0.843
1.50	0.981	0.641
2.50	0.933	0.529
3.50	0.856	0.412
4.50	0.808	0.314
5.50	0.712	0.235
6.50	0.606	0.190
7.50	0.471	0.131
8.50	0.298	0.039
9.50	0.144	0.020
10.50	0.048	0.000
11.50	0.010	0.000
13.00	0.000	0.000

AUROC:  
.81, SE=.026,  $p < .001$ , 95%CI= .76-.86

# Summary

- We successfully established risk stratification index to predicted MF following ASD surgery using individual's baseline demographics, radiographic parameters, and surgical invasiveness that would normally be collected when considering surgical treatment for ASD.
- This index can help surgeon identify patients with a high risk of MF, treat modifiable variables to mitigate the risk of MF in ASD surgery.
- Further validation in a different patient population may improve the accuracy of this index.