Rigshospitalet
University of Copenhagen

Ability of the Global Alignment and Proportion score to Predict Mechanical Failure in ASD

– Validation in 149 patients with Two-years Follow-up.

Tanvir J Bari[1], Søren Ohrt-Nissen, Benny Dahl[2], Martin Gehrchen[1]

[1]Spine Unit, Department of Orthopedic Surgery, Rigshospitalet, Copenhagen University Hospital, Denmark

[2]Department of Orthopedics and Scoliosis Surgery, Texas Children's Hospital and Baylor College of Medicine, TX, USA

Correspondence: bari.tanvir@gmail.com

Introduction

- Mechanical failure following surgery for Adult Spinal Deformity (ASD) remains a frequent indication for revision surgery.
- Recently, the Global Alignement and Proportion (GAP) score was developed for predicting revision surgery due to mechanical failure[1].
- The current study aimed to validate these findings.

[1] *Yilgor, Caglar, et al. "Global Alignment and Proportion (GAP) Score: development and validation of a new method of analyzing spinopelvic alignment to predict mechanical complications after adult spinal deformity surgery." The Spine Journal 17.10 (2017): S155-S156.*

- The GAP score comprises 4 radiographic parameters calculated as the difference between measured and ideal angle in addition to an age-parameter (Figure 1).
- Based on these parameters patients are given a total score between 0 and 13 and further subcategorized into three categories (Figure 2).

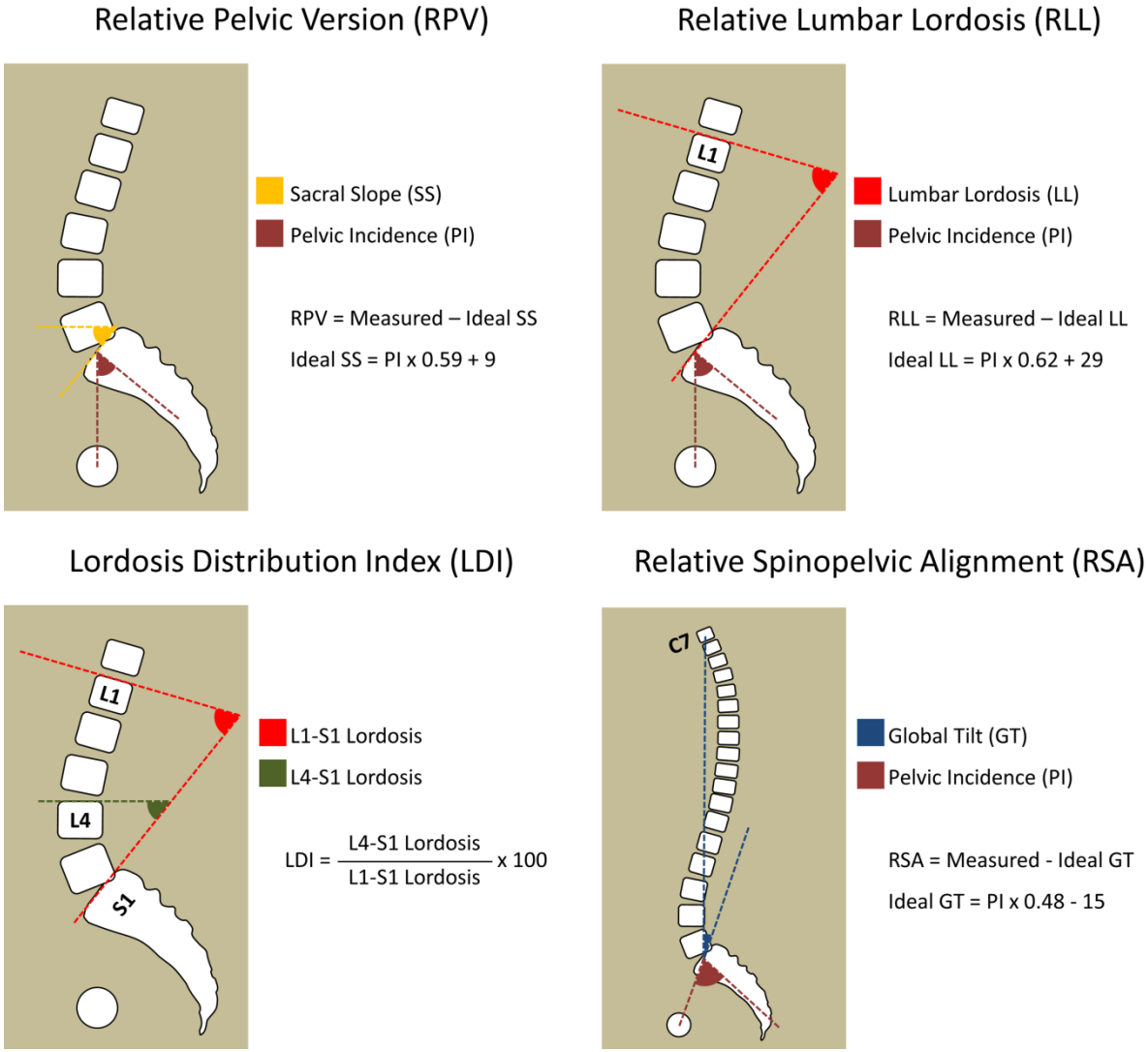

Figure 2. Methods for calculating radiographic components. Relative Pelvic Version, Relative Lumbar Lordosis and Relative Spinopelvic Alignment are calculated based on the measured angle in relation to the ideal angle.

Global Alignment and Proportion (GAP) score

RPV Groups		Score
< -15 :	Severe Retroversion	3
-15 to -7.1 :	Moderate Retroversion	2
-7 to 5 :	Aligned	0
> 5 :	Anteversion	1

RLL Groups		Score
< –25 :	Severe Hypolordosis	3
-25 to -14.1 :	Moderate Hypolordosis	2
-14 to 11 :	Aligned	0
> 11 :	Hyperlordosis	3

LDI Groups		Score
< 40 % :	Severe Hypolordotic Maldistribution	2
40 to 49 % :	Moderate Hypolordotic Maldistribution	1
50 to 80 % :	Aligned	0
> 80 % :	Hyperlordotic Maldistribution	3

RSA Groups		Score
> 18 :	Severe Hypolordotic Maldistribution	3
18 to 10.1 :	Moderate Hypolordotic	1
10 to -7 :	Maldistribution	0
< -7 :	Aligned	1
	Hyperlordotic Maldistribution	

Age Groups		Score
< 60 years :	Adult	0
≥ 60 years :	Elderly Adult	1

GAP Categories

Total score: 0 to 2	Total score: 3 to 6	Total score: 7 to 13
Proportioned	**Moderately Disproportioned**	**Severely Disproportioned**

Figure 1. Methods for calculating GAP score and category.

Methods

- All patients undergoing ASD surgery with instrumentation of ≥4 levels over a three-year period with at least 2 years of follow-up were included at a single tertiary center (2013-2015).
- Revision surgery was defined as revision due to mechanical failure.
- Postoperative GAP score and category was calculated in accordance to the original work.
- Patients were followed for a minimum of two years.

Statistics

- Receiver operating characteristic (ROC) curves were used to calculate the Area under the curve (AUC) in assessing the GAP score´s diagnostic accuracy of predicting mechanical failure or revision surgery.
- GAP categories were analyzed for association to the two outcome variables using Cochrane-Armitage test of trend.

Results

- A consecutive cohort of 184 patients were identified for inclusion.
- 35 (19%) were lost to follow-up.
- This left 149 patients for final inclusion.
- Statistical analyses showed no significant correlation between GAP score or category and either mechanical failure or revision surgery.

Table 1. Demographics		
Age (years)	Mean (SD)	57.4 (15.9)
Instrumented vertebrae (No.)	Mean (SD)	12.0 (3.5)
Sex, female (No.)	Female	105 (70.5%)
Previous spine surgery (No.)		88 (59.1%)
3-Column Osteotomy (No.)		86 (57.7%)
Follow-up (months)	Median [IQR]	32 [24-57]
Mechanical failure (No.)		76 (51.0%)
Proximal junctional kyphosis (No.)		4 (2.7%)
Proximal junctional failure (No.)		10 (6.7%)
Distal junctional failure (No.)		1 (0.7%)
Rod breakage (No.)		57 (38.3%)
Other mechanical failure (No.)		17 (11.4%)
Revision surgery (No.)		52 (34.9%)
Preoperative GAP score	Median [IQR]	10 [6-12]
Postoperative GAP score	Median [IQR]	4 [2-7]
Preoperative GAP category (No.)	Proportioned	7 (4.7%)
	Moderately Disproportioned	32 (21.5%)
	Severely Disproportioned	110 (73.8%)
Postoperative GAP category (No.)	Proportioned	40 (26.8%)
	Moderately Disproportioned	64 (43.0%)
	Severely Disproportioned	45 (30.2%)
Change in GAP score	Mean (SD)	-4.1 (4.1)

SD: Standard deviation; GAP: Global Alignment and Proportion; IQR: Interquartile range

Table 2. Accuracy of the GAP score as a predictor of revision surgery or mechanical failure.

	Revision surgery	Mechanical failure
	AUC (95% CI)	AUC (95% CI)
Receiver operating characteristics	0.49 (0.39-0.59)	0.50 (0.40-0.59)
	Chi-squared test (p-value)	Chi-squared test (p-value)
Cochran-Armitage test of trend	1.16 (p=0.28)	0.30 (p=0.58)
Univariate logistic regression	Odd ratio (95% CI) [p-value]	Odd ratio (95% CI) [p-value]
GAP score	1.01 (0.91-1.11) [p=0.28]	1.00 (0.91-1.10) [p=0.97]
GAP categories		
Proportioned	Reference	Reference
Moderately Disproportioned	1.42 (0.76-2.66) [p=0.28]	1.14 (0.65-2.18) [p=0.28]
Severely Disproportioned	0.87 (0.50-1.53) [p=0.63]	0.94 (0.55-1-60) [p=0.81]

GAP: Global Alignment and Proportion; AUC: Area under the curve; CI: Confidence interval

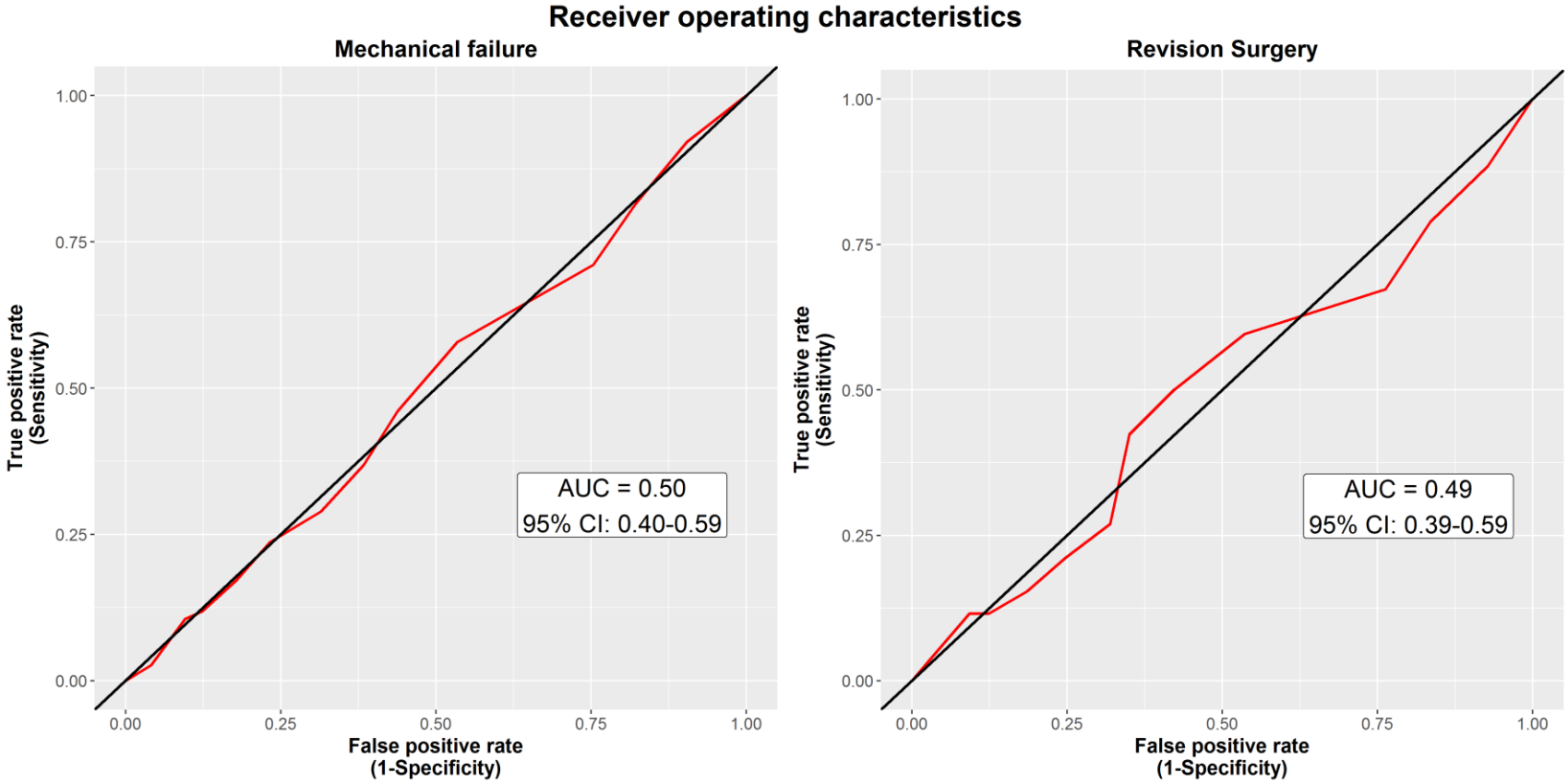

Figure 3. Receiver operating characteristic curves illustrating the diagnostic accuracy of the Global Alignment and Proportion (GAP) score in predicting mechanical failure and revision surgery. An Area Under the Curve (AUC) of < 0.7 indicates “no or low discriminatory power” of diagnostic accuracy.

Conclusion

- We found no association between GAP score and revision surgery due to implant failure.
- Characteristics of the current cohort differed slightly from the original in terms previous instrumentation and rate of 3-Column Osteotomy procedures.
- Hence, the predictive ability of the GAP score may be limited by surgical factors such as previous instrumentation and/or extent of osteotomies.

Conflicts of interest

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Spine Unit, Department of Orthopedic Surgery,
Rigshospitalet, University Hospital of Copenhagen