Compensatory action of lower extremities In patient with adult spinal deformity (ASD); Implication for the postoperative sagittal alignment

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1. Adult spinal deformity (ASD)

- Compensatory mechanisms
  - thoracic hypokyphosis (hyperextension)
  - pelvic retroversion
  - **knee flexion**

- With the normal sagittal balance, knee flexion should be spontaneously corrected after surgery.

- With persistent knee flexion, inadequate decompensation at the level of spine and pelvis

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Materials and Methods

1. CB and UB group (SVA <5cm)

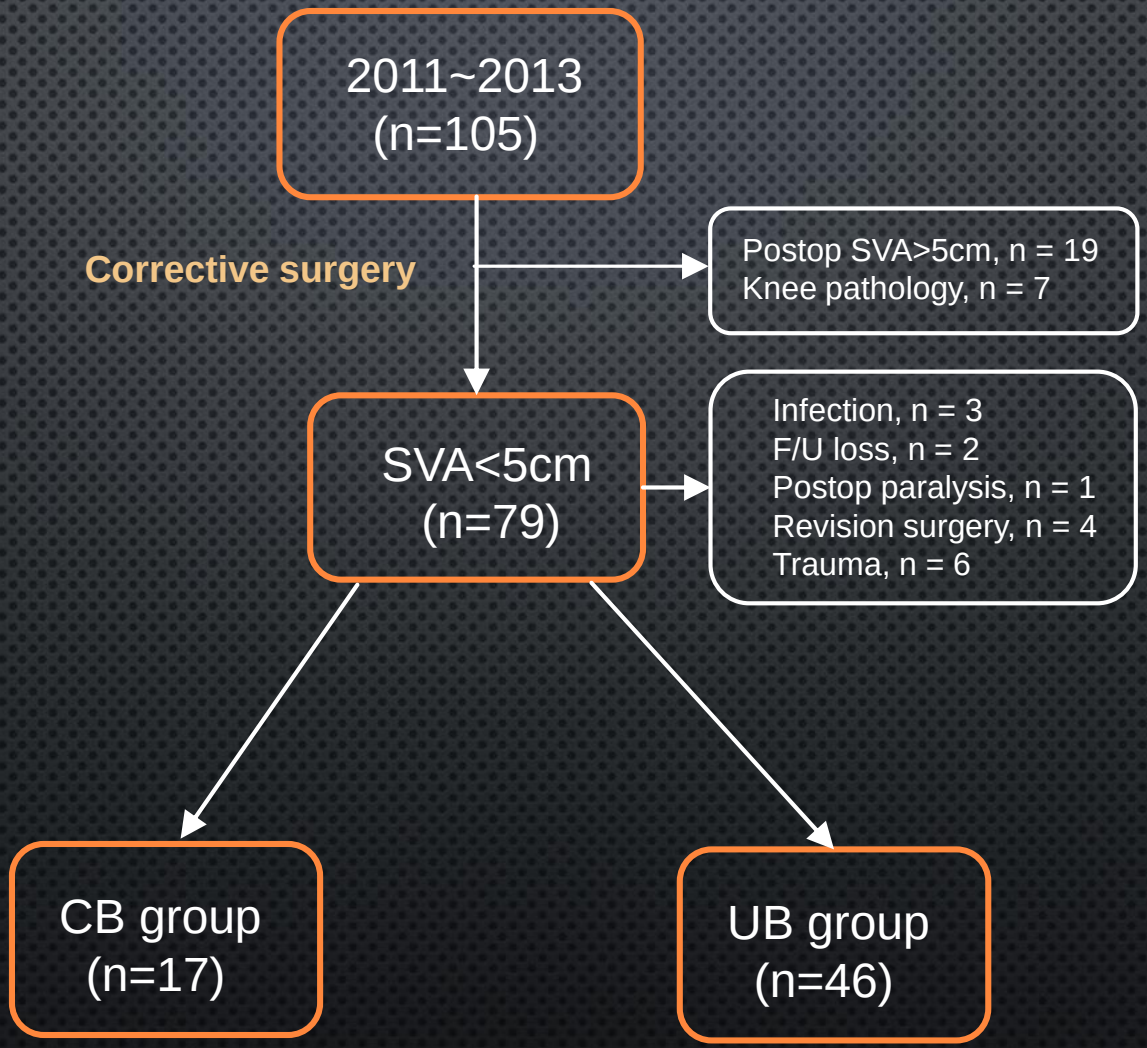
- **Compensated balanced (CB) group**
  : postoperative SVA < 5cm, knee flexion **>** 5°

- **Uncompensated balanced (UB) group**
  : postoperative SVA < 5cm, knee flexion **<** 5°†

†*Lamartina C et al. Eur Spine J. (2014)*

02

Materials and Methods



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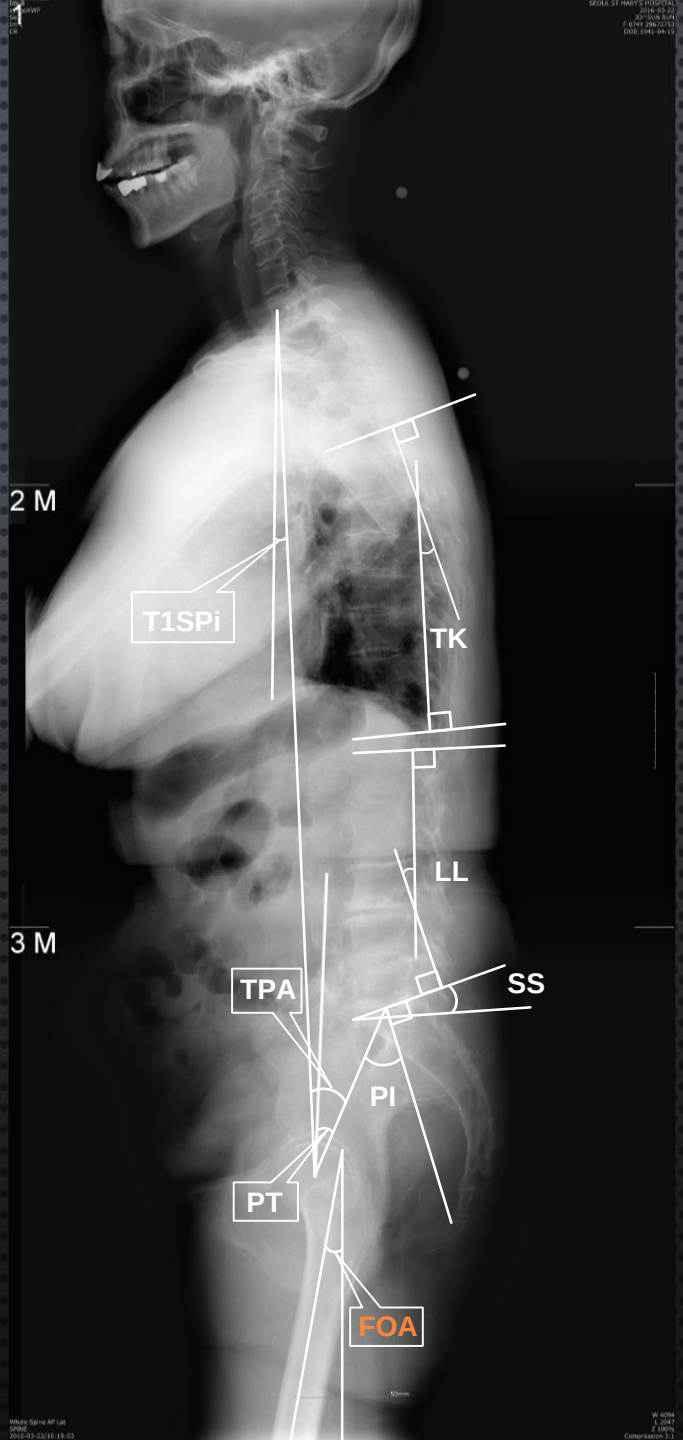
Materials and Methods

- T1SPi: T1 spinopelvic inclination
- TPA: T1 pelvic angle
- FOA: angle of femoral obliquity (knee flexion)

- TK: thoracic kyphosis
- LL: lumbar lordosis
- PI: pelvic incidence
- PT: pelvic tilt
- SS: sacral slope



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Results

1. Patients population

	CB	UB	*P*
No. of patients	17	46	NI
Mean age (year)	63.14 ± 8.11	62.41 ± 6.31	0.415
Gender(male/female)	7/10	18/28	0.553
BMD (T-score)	-1.83 ± 2.11	-1.47 ± 1.88	0.201
BMI (kg/m^2)	20.3 ± 3.2	22.1 ± 4.1	0.154
No. of fused level	5.58 ± 1.48	4.77 ± 0.83	0.527
Upper instrumented vertebra†	11.31 ± 1.24	12.22 ± 0.22	0.281
Lower instrumented vertebra†	18.31 ± 1.55	18.05 ± 0.89	0.344

† A numerical value has been attributed to each vertebral level (T1=1. T2=2…L1=13, 18 = sacrum)
NI indicated not involved

Results

2. Comparison in pre- and postoperative radiographic parameters between groups

	Preoperatively			1 month postoperatively		
	CB	UB	*P*	CB	UB	*P*
FOA (°)	14.85 ± 2.17 >	10.44 ± 4.87	0.014	11.23 ± 2.88 >	4.52 ± 1.04	<0.001
SVA (mm)	105.34 ± 10.28 >	89.72 ± 8.54	0.003	35.44 ± 15.28	27.37 ± 24.11	0.028
TPA (°)	38.41 ± 8.54 >	34.77 ± 10.2	0.043	26.53 ± 10.88 >	20.83 ± 8.25	<0.001
T1SPi (°)	9.85 ± 7.75	2.74 ± 6.87	0.037	3.11 ± 5.24	-1.73 ± 3.54	0.045
TK(°)	-16.65 ± 15.66 >	-23.45 ± 15.87	<0.001	-22.48 ± 13.21	-25.18 ± 14.88	0.517
PI (°)	53.24 ± 12.35	51.41 ± 13.25	0.216	53.18 ± 13.22	52.02 ± 9.66	0.381
LL (°)	18.23 ± 15.21	24.18 ± 13.21	<0.001	33.85 ± 8.60	35.84 ± 10.99	0.254
PT (°)	28.42 ± 8.65 <	32.15 ± 7.41	0.032	23.71 ± 6.51	21.45 ± 7.12	0.439
SS (°)	26.11 ± 9.97	19.89 ± 8.94	0.042	30.84 ± 8.24	31.33 ± 8.44	0.721
PI-LL (°)	35.07 ± 18.55	27.47 ± 14.10	0.018	20.14 ± 11.48	16.63 ± 13.25	0.031

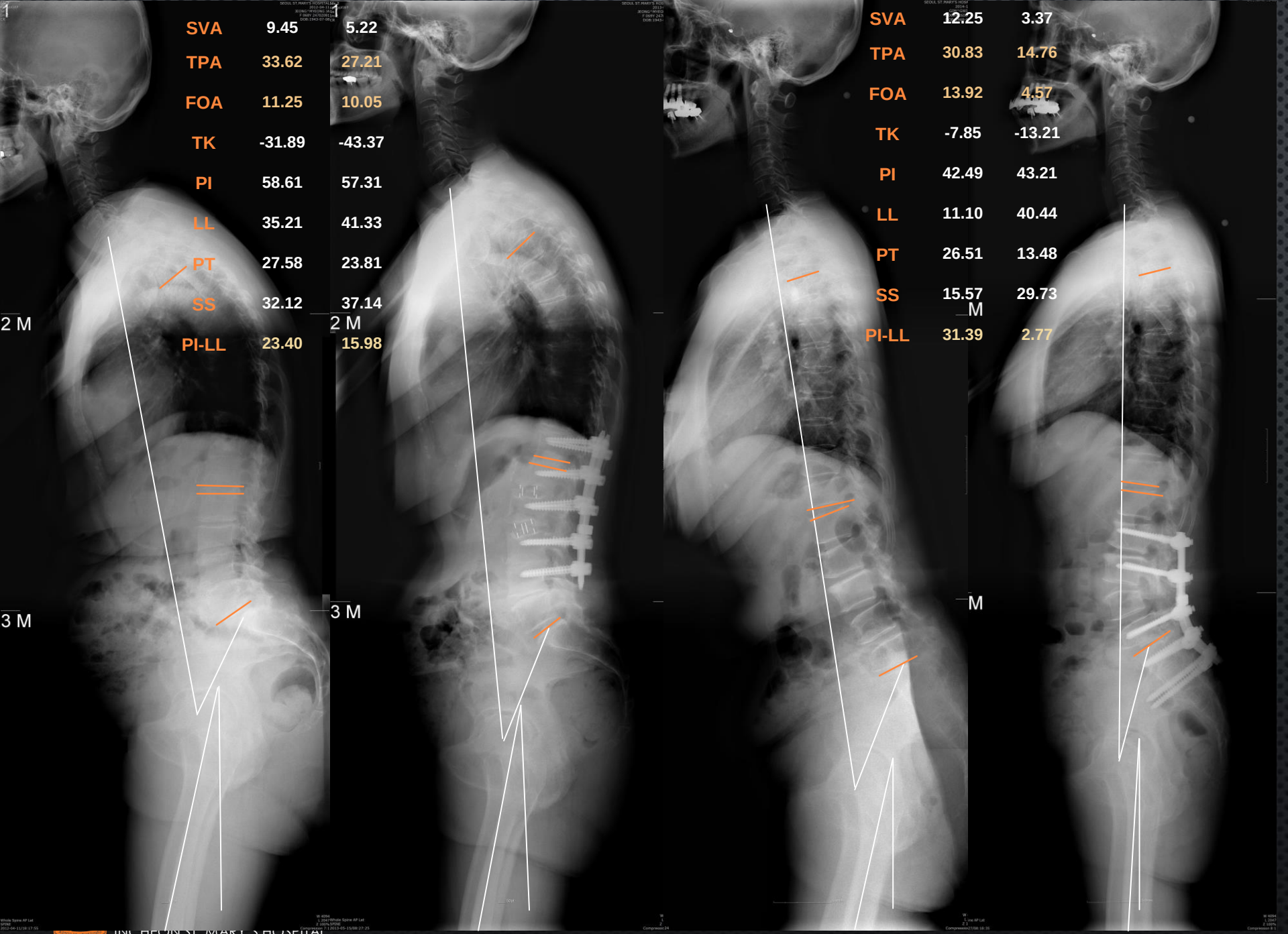
Results

3.Decompensating action of spine, pelvis, and lower extremity in relation to the restoration of lumbar lordosis

	CB		UB	*P*
ΔTK/ΔLL	0.40	>	0.14	0.031
ΔPT/ΔLL	0.31	<	0.88	0.015
ΔFOA /ΔLL	0.23		0.54	0.152

5. Matrix of correlations among the changes of parameters

	ΔFOA	ΔSVA	ΔTPA	ΔTK	ΔT1SPi	ΔLL	ΔPT	ΔSS	Δ*PI-LL*
ΔFOA	1	0.52†	0.63†	-0.48†	0.56†	0.19	0.55†	0.53†	*0.41*†
ΔSVA		1	0.82†	0.45†	0.74†	-0.07	0.21	0.21	*-0.72*
ΔTPA			1	0.57†	0.64†	0.21	0.35	0.35	0.21
ΔTK				1	0.29	0.42†	0.29	0.29	0.41†
ΔT1SPi					1	-0.25	-0.49†	-0.49†	-0.24
ΔLL						1	0.54†	0.54†	0.99†
ΔPT							1	0.92†	0.54†
ΔSS								1	0.54†
ΔPI-LL									1


SVA 9.45 5.22
TPA 33.62 27.21
FOA 11.25 10.05
TK -31.89 -43.37
PI 58.61 57.31
LL 35.21 41.33
PT 27.58 23.81
SS 32.12 37.14
PI-LL 23.40 15.98
2 M
3 M
2 M
3 M
SVA 12.25 3.37
TPA 30.83 14.76
FOA 13.92 4.57
TK -7.85 -13.21
PI 42.49 43.21
LL 11.10 40.44
PT 26.51 13.48
SS 15.57 29.73
PI-LL 31.39 2.77
M
M

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Conclusions

- Even after the restoration of normal SVA, persistent knee flexion could demonstrate the limited decompensation of retroversed pelvis.
- TPA rather than SVA is more effective in indicating the persistent compensatory action of lower extremity.
- The compensatory knee flexion could be correlated with the correction of the PI-LL mismatch.

Conflict of Interest Statement

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