



# Longitudinal Impact of a Hybrid Brace on Sagittal Alignment in AIS: A 1-Year Follow-up Study

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## Purpose

Traditional rigid braces for AIS often cause 'flat-back' syndrome by unintended loss of sagittal curvature. The Spinamic® brace, a novel hybrid spinal orthosis using flexible fabric-based components, is reported to be effective on coronal alignment, but its impact on sagittal alignment remains limited. This study aims to evaluate its capability to preserve sagittal parameters in AIS individuals, providing clinical evidence for its multi-planar balancing effectiveness.

## Methods

● **Study design and setting** : retrospective study, 47 AIS individuals, followed for 1-year, in single tertiary institute

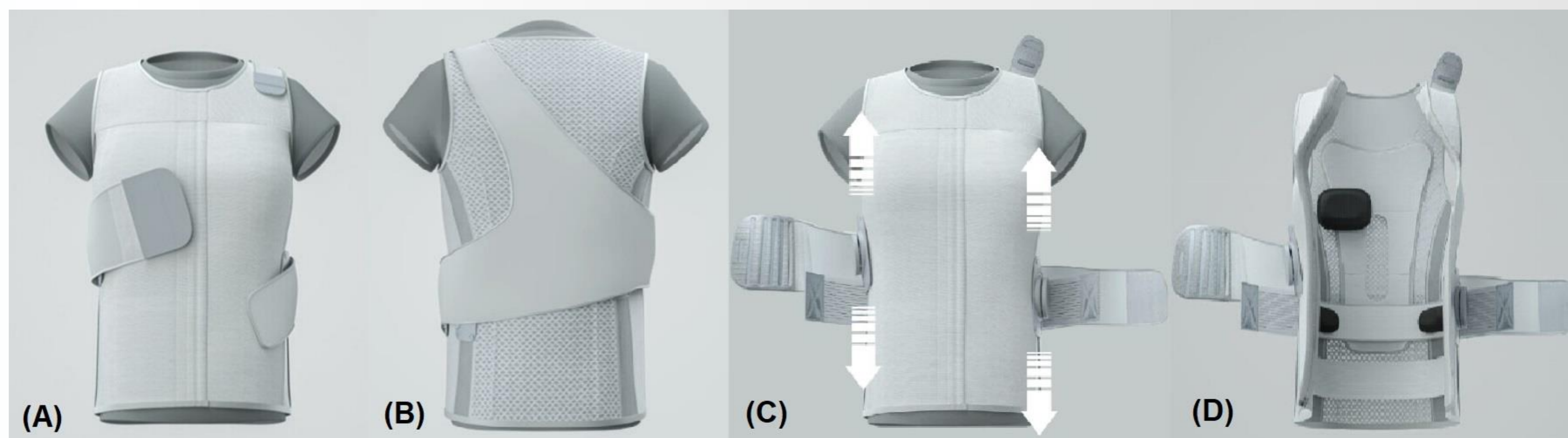
● **AIS diagnosis & evaluation** : by EOS system (Biospace Med, Paris, France)

- thoracic kyphosis angle(TKA), lumbar lordosis angle(LLA), sagittal vertical axis(SVA), pelvic tilt(PT), sacral slope(SS)

- skeletal maturity: Risser stage

- follow-up period: initial, 6 months, 1 year

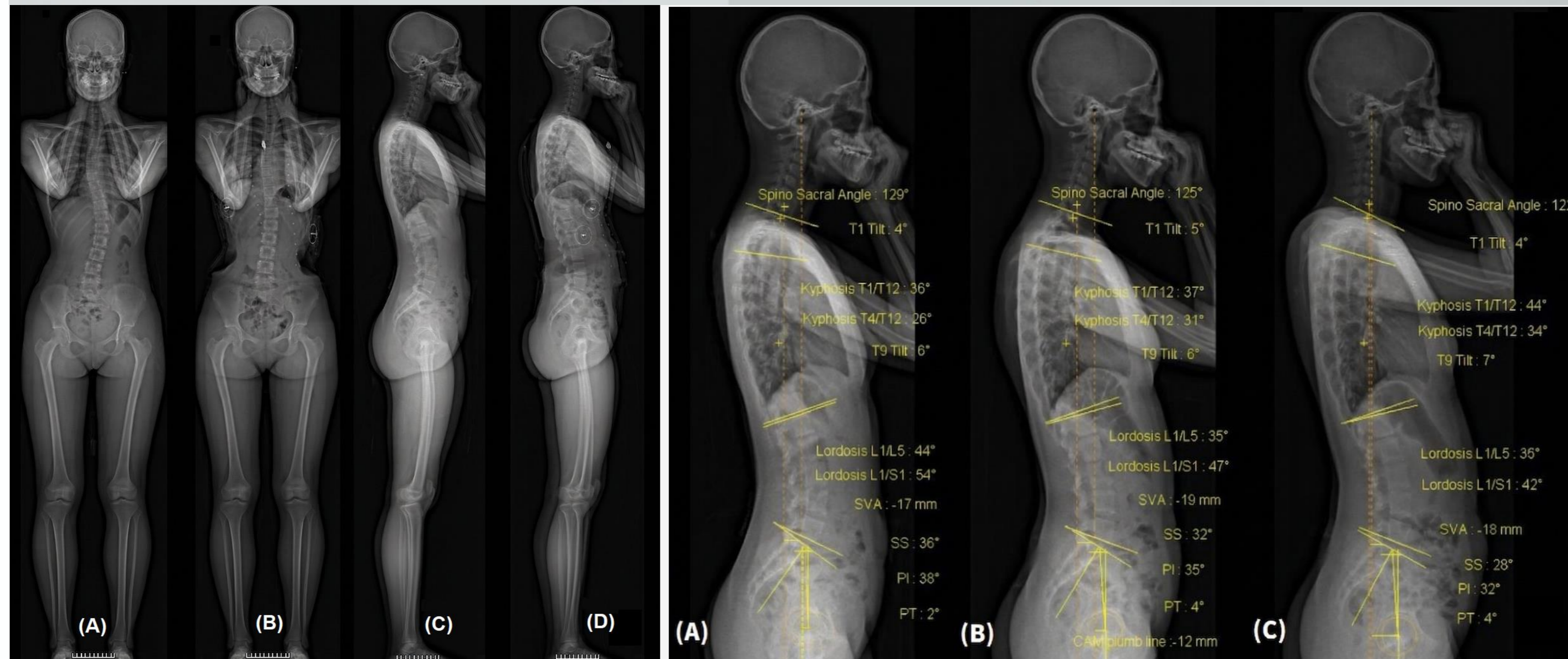
● **Spinal orthosis** : Spinamic® brace (VNTC, Seoul, Republic of Korea)



**Fig. 1.** Overall views of the Spinamic® brace. (A) Anterior view. (B) Posterior view. (C) Adjustable 3-point pressure system using shoulder strap and bilateral longitudinal rails. (D) Inner view.

**Fig. 2.** Standing images in AIS individual by the EOS system.

(A) Coronal view.  
(B) Coronal view with Spinamic® brace.  
(C) Sagittal view.  
(D) Sagittal view with Spinamic® brace.



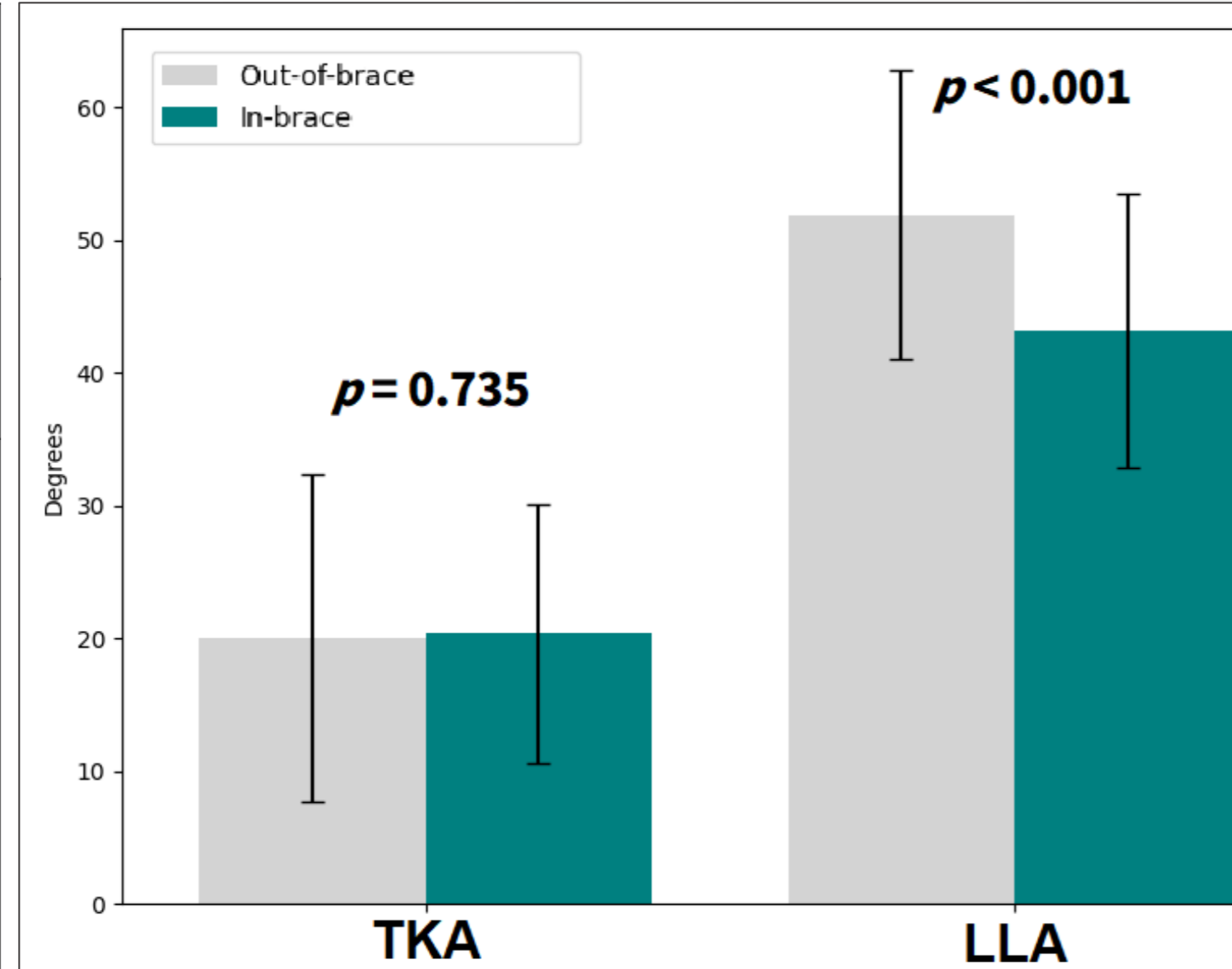
**Fig. 3.** Changes in sagittal parameters over time after wearing Spinamic® brace in AIS individual. (A) Initial status. (B) 6 months later. (C) 1 year later.

## Results

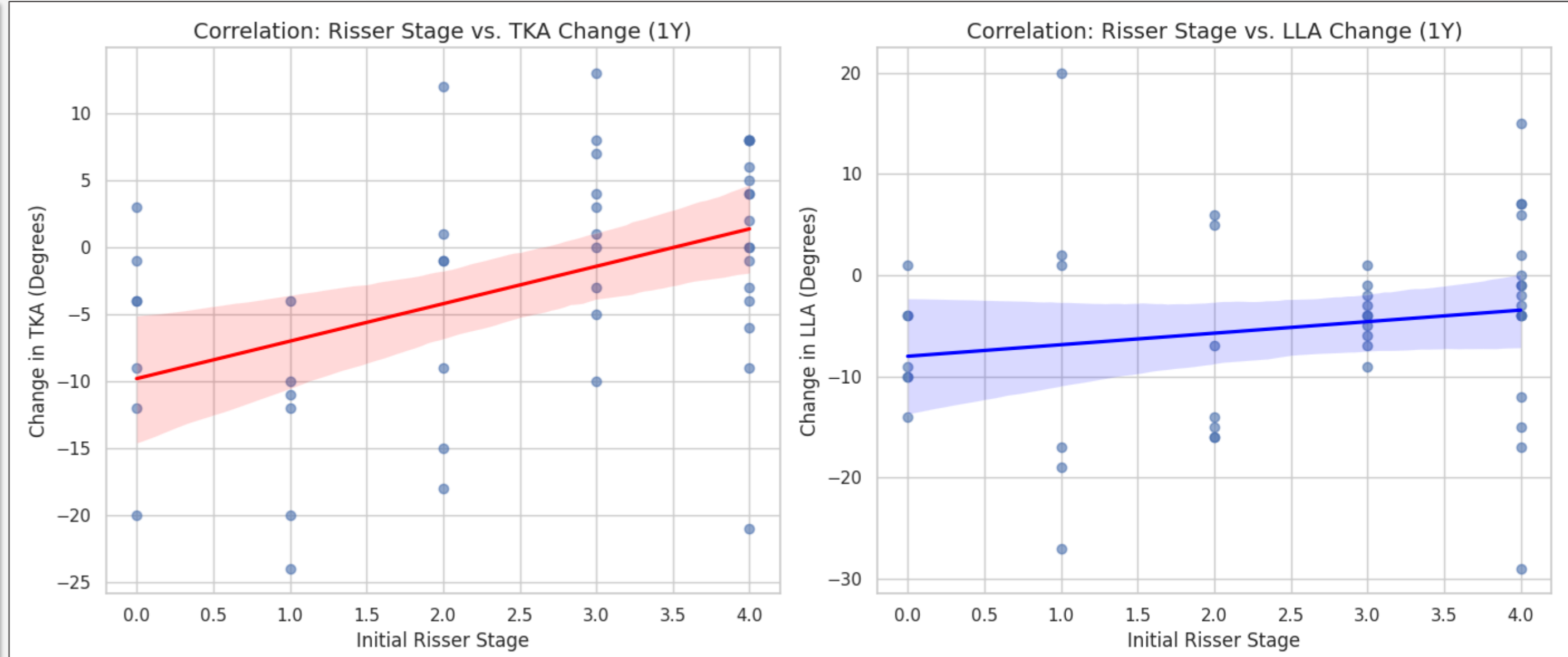
**Table 1. Characteristics of Study Participants (N=47)**

Characteristics	Value
Age (year)	13.00±1.50
Sex (M/F)	15 / 32
BMI (kg/m <sup>2</sup> )	18.52±2.14
Skeletal Maturity	
Lower (Risser stage 0-2)	20 (42.6%)
Higher (Risser stage 3-5)	27 (57.4%)

BMI, body mass index. Values are presented as mean±standard deviation, or numbers.



**Fig. 4.** Immediate effect of the Spinamic® brace in sagittal alignment. Lumbar lordosis angle (LLA) was significantly reduced ( $p < 0.001$ ) immediately upon wearing the brace, but thoracic kyphosis angle (TKA) was maintained ( $p = 0.735$ ).

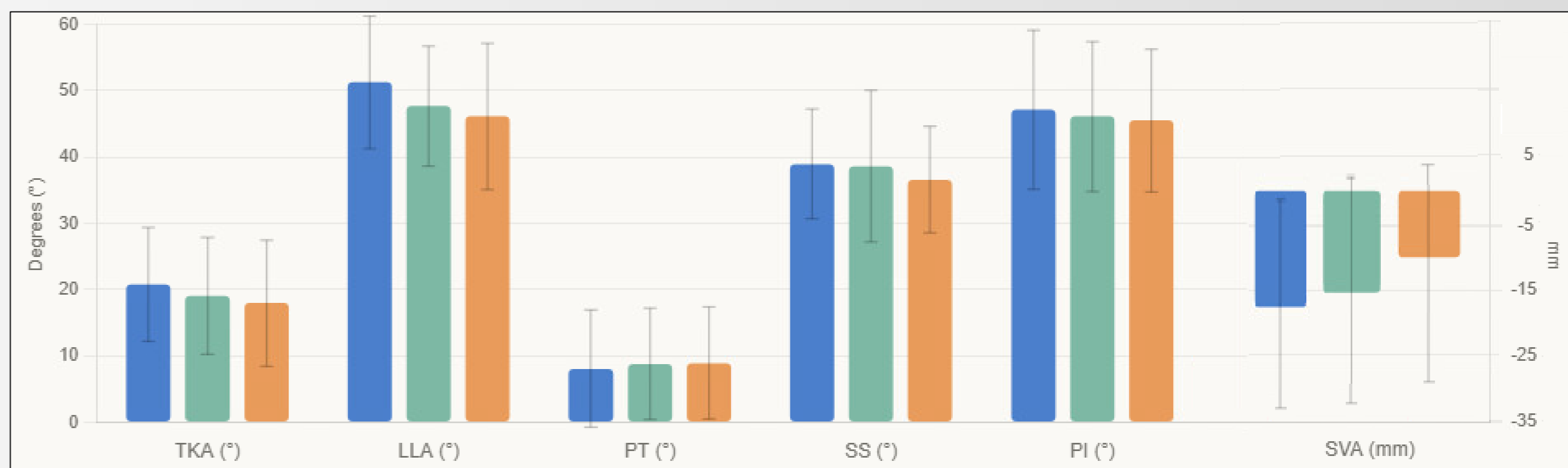


**Fig. 5.** Correlation between initial Risser stage and 1-year changes in sagittal alignments. (A) a positive correlation ( $r = 0.452$ ) was observed between the Risser stage and TKA changes, indicating that individuals with higher growth potential exhibited more dynamic thoracic realignment. (B) LLA changes showed a consistent decreasing trend regardless of skeletal maturity ( $r = 0.174$ ), suggesting a universal corrective effect on compensatory lumbar hyperlordosis.

**Table 2. Longitudinal Changes in Sagittal and Pelvic Parameters (N=47)**

Parameter	Initial	6 Months	1 Year	p-value
TKA (°)	20.79±8.61	19.06±8.84	17.98±9.50	0.315
LLA (°)	51.25±9.98	47.70±9.03	46.13±11.02	<b>0.042*</b>
SVA (mm)	-15.57±16.27	-15.34±17.51	-10.00±18.85	0.104
Pelvic Tilt (°)	8.11±8.82	8.83±8.37	8.96±8.43	0.873
Sacral Slope (°)	38.98±8.25	38.64±11.42	36.60±8.02	0.412
Pelvic Incidence (°)	47.15±11.98	46.11±11.29	45.51±10.75	0.779

TKA, thoracic kyphosis angle; LLA, lumbar lordosis angle; SVA, sagittal vertical axis. Values are presented as mean±standard deviation. \*Significant at  $p < 0.05$ .



**Fig. 6.** Longitudinal changes in sagittal and pelvic parameters over 1 year after wearing Spinamic® brace in AIS individuals. The bar chart visualize mean values at three distinct time points: Initial (blue), 6 months (green), and 1 year (orange). The error bars indicates standard deviations. A significant longitudinal decrease was observed in lumbar lordosis angle (LLA) ( $p = 0.042$ ), while thoracic kyphosis angle (TKA) and pelvic parameters remained stable. LLA demonstrated a coupled reduction with sacral slope (SS) leading to improved sagittal vertical axis (SVA) toward a more neutral position.

## Conclusions

Spinamic® brace effectively prevents thoracic flattening while normalizing compensating lumbar hyperlordosis through a synchronized realignment of the lumbosacral complex. The flexible tension-based mechanism allows for adaptive correction according to the AIS individual's skeletal maturity, providing a biomechanical advantage in maintaining physiological sagittal alignment compared to traditional rigid orthoses.