Distribution of Spinopelvic Alignment Classifications Among Primary Total Hip Arthroplasty Patients: A Single-Center Study

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INTRODUCTION: Dislocation after total hip arthroplasty (THA) remains a leading cause of revision and resource utilization. In recent years, the assessment of spinopelvic alignment (SPA)—and particularly the Hip–Spine Classification—has been advocated to refine patient-specific cup positioning and to mitigate instability risk [1, 2]. However, because the classification was developed and validated predominantly in Western cohorts, its applicability to Japanese patients is uncertain. Robust, population-specific data are needed to clarify whether the distribution of Hip–Spine phenotypes differs in Japanese THA candidates and whether recommended cup targets derived from Western data generalize to this population.

METHODS: We conducted a single-center observational study including 160 consecutive primary THA patients treated from May 2024 onward (27 men, 133 women; mean age 68.8 years). Preoperative standing and sitting lateral radiographs were obtained using a standardized protocol, and SPA was evaluated. Patients were categorized into one of four phenotypes according to the Hip–Spine Classification proposed by Vigdorchik et al. [1, 2]; the distribution was compared with U.S. reports to highlight potential inter-population differences.
Postoperatively, acetabular radiographic inclination (RI) and radiographic anteversion (RA) were measured using Hip Scouter v0.9 (Zimmer Biomet G.K.); we assessed whether values fell within (i) the Lewinnek "safe zone" (RI 30–50°, RA 5–25°) [3] and (ii) the cup-positioning targets recommended by the Hip–Spine Classification. The target ranges were those defined by Vigdorchik et al. [1]; a uniform ±3° tolerance, reflecting robot-assisted surgery accuracy, was applied across all groups. Measurements were performed three times on the 1-week supine AP pelvis radiograph and averaged to reduce random error; cases with non-evaluable radiographs were excluded from the respective analyses.
Analytically, we summarized phenotype proportions and conformity rates to each target range descriptively; between-cohort contrasts with published U.S. data were descriptive and intended to generate hypotheses for future inferential work. This study was approved by the institutional ethics committee.
RESULTS: A total of 160 patients were successfully categorized according to the Hip–Spine Classification. The overall distribution was Type 1A: 40% (n=64), Type 1B: 13% (n=21), Type 2A: 31% (n=49), and Type 2B: 16% (n=26). Compared with previously published U.S. series, our cohort demonstrated fewer Type 2A and relatively more Type 2B patients, suggesting population-level differences in sagittal alignment characteristics.
Mean postoperative radiographic inclination (RI) and radiographic anteversion (RA) across the cohort were within expected ranges, although variability was observed between phenotypes. When conformity to the Lewinnek safe zone (RI 30–50°, RA 5–25°) was assessed, proportions were high in all subgroups: 1A: 91%, 1B: 90%, 2A: 90%, and 2B: 92%.
In contrast, the percentage of cases that precisely matched the cup orientation targets recommended by the Hip–Spine Classification was markedly lower: only 31% in Type 1A, 0% in Type 1B, 18% in Type 2A, and 8% in Type 2B . This discrepancy highlights a potential misalignment between guideline-derived targets and the actual morphological characteristics of Japanese patients.
Notably, no early dislocations were observed in the present series despite the limited proportion of patients achieving the classification-based cup orientation, suggesting that functional stability may not strictly depend on those theoretical targets in this population.
DISCUSSION: Japanese primary THA patients exhibited a distinct distribution of spinopelvic phenotypes compared with Western cohorts. Specifically, our series showed a relative enrichment of Type 2B and a reduction in Types 1A and 2A [1]. This shift suggests population-specific factors influencing sagittal alignment. Epidemiological studies have documented that vertebral compression fractures are more prevalent in Japanese populations compared with Western cohorts [4]. Such fractures diminish lumbar lordosis and promote posterior pelvic tilt, which may underlie the higher proportion of Type 2B phenotypes observed. This mechanistic link highlights the importance of incorporating vertebral fracture burden into the interpretation of spinopelvic alignment patterns in Japan.
Although the majority of acetabular cups in our cohort were placed within the Lewinnek safe zone, only a small fraction conformed to the narrow Hip–Spine classification targets [2]. These angular windows were designed under the assumption of robotic-assisted THA, whereas all procedures in our institution were performed manually. The Hip–Spine Classification is a simple and important framework; however, because robotic THA is not yet widely used in Japan and ethnic differences exist, further investigation is warranted.

SIGNIFICANCE/CLINICAL RELEVANCE: The Hip–Spine Classification provides a useful paradigm for functional cup placement, but our data indicate that Japanese patients display distinct distributions of spinopelvic phenotypes and low conformity to classification-based targets. Consideration of ethnic differences and surgical context is essential to refine population-appropriate recommendations and optimize stability in Japanese THA patients.

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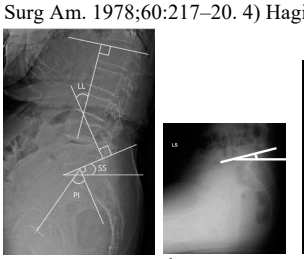

a. b. c.

	Spine alignment	
	Normal alignment	Flatback deformity
	PI-LL<10°	PI-LL>10°
Normal mobility (ΔSS>10°)	1A	2A
Stiff spine (ΔSS<10°)	1B	2B

Figure1. Hip–Spine Classification proposed by Vigdorchik et al.
a. Standing plain radiograph, b. Seated plain radiograph, c. Hip–Spine Classification proposed
PI: Pelvic Incidence, LL: Lumbar Lordosis, SS: Sacral Slope, ΔSS: Change in sacral slope from standing to seated

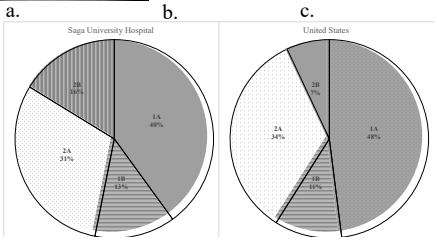

Figure2. Distribution of Hip-Spine Classification

Type		RI	RA	All cases	Eligible cases
1A		40°-45°	20°-25°	64	20
1B		45°	25°-30°	21	0
2A	PT<13	40°-45°	20°-25°	12	3
	PT>13	40°	20°-25°	37	6
2B		40°	25°	26	2

Table 1. Concordance with cup positioning angles based on the Hip–Spine Classification