J Turk Spinal Surg 2026;37(1):9-16
DOI: 10.4274/jtss.galenos.2025.93063

SPINAL OUTCOMES AND GAP SCORE ANALYSIS FOLLOWING SEQUENTIAL TOTAL HIP ARTHROPLASTY IN HIP-SPINE SYNDROME

Fatih Barça, Ekin Barış Demir

University of Health Sciences Türkiye, Ankara Etlik City Hospital, Clinic of Orthopaedics and Traumatology, Ankara, Türkiye

ABSTRACT

Objective: The study aimed to evaluate changes in early clinical outcomes and radiological parameters before and after two surgeries in patients with hip-spine syndrome (HSS) who underwent staged bilateral total hip arthroplasty (THA).

Materials and Methods: Sixty three patients (mean age, 56.6 years) who underwent staged bilateral THA and had spinal symptoms were included. Hip disability and osteoarthritis outcome score (HOOS), Oswestry disability index (ODI), and Roland-Morris disability questionnaire (RMDQ), together with radiological parameters (leg length discrepancy and pelvic obliquity), were assessed preoperatively, at three months after the first THA, and at three months after the second THA. Changes after surgeries were compared, and correlations between radiological parameters and scores were analyzed. Global alignment and proportion (GAP) scores were evaluated in a subgroup of thirteen patients.

Results: HOOS scores improved after both surgeries (32.7±5.8, 60.9±5.8, and 91.7±2.3). Median RMDQ scores were 17-5-4, and median ODI scores were 55-15-10. After the second surgery, RMDQ and ODI scores worsened in 16 (25.4%) and 14 (22.2%) patients, respectively. Improvements in both scores were significantly greater after the first surgery than after the second. No correlations were found between radiological parameters and improvements in RMDQ and ODI scores. GAP scores did not change after surgeries.

Conclusion: In HSS patients undergoing staged bilateral THA with hip-first approach, lumbar symptoms improved after first surgery but not the second surgery in the same extent at short-term. Lumbar changes were unrelated to changes in coronal pelvic parameters, and global sagittal balance remained unchanged.

Keywords: Hip-first, global alignment and proportion score, patient-reported outcome measures, bilateral total hip arthroplasty

INTRODUCTION

Hip-spine syndrome (HSS), first described by Offierski and MacNab[1] in 1983, refers to the coexistence of degenerative lumbar pathology and hip degeneration. When degenerative hip disease and spinal disorders (spinal stenosis, facet arthropathy, lumbar disc degeneration, spondylolisthesis, or degenerative scoliosis) occur together, their interaction often amplifies both hip- and spine-related symptoms[2]. In many patients, this overlap also creates diagnostic uncertainty, making it challenging to determine whether the primary source of symptoms is the lumbar spine or the hip[2,3].

There is currently no clear consensus regarding which pathology should be addressed first in patients with HSS. Some studies recommend prioritizing treatment of the hip joint[4,5], whereas others advocate treating the spine first[6]. In our clinical practice, when imaging demonstrates both degenerative hip disease and spinal pathology in patients presenting with hip pain and HSS is suspected, we routinely perform total hip arthroplasty (THA) as the initial intervention. Subsequent spinal treatment is considered only if spinal symptoms persist following THA.

Degenerative hip osteoarthritis is seen bilaterally in 34% of patients with lumbar degenerative disease[7]. In this patient group, clinical scores were reported to be worse both at baseline and after treatment[7]. Reviewing the current literature, we observed that there are very few studies evaluating the spinal status (radiographic or clinical) of patients with HSS and bilateral degenerative hip disease who underwent two-stage bilateral THA[8-10].

Our clinical observations indicate that in patients with HSS and bilateral degenerative hip disease, lumbar symptoms improve substantially after the first THA, whereas the contralateral THA provides no additional reduction in lumbar complaints. The primary aim of this study is therefore to evaluate short-term changes in clinical and radiological outcomes in patients with HSS who undergo staged bilateral THA, comparing results after

Address for Correspondence: Fatih Barça, University of Health Sciences Türkiye, Ankara Etlik City Hospital, Clinic of Orthopaedics and Traumatology, Ankara, Türkiye
E-mail: fatihbarca@hotmail.com
ORCID ID: orcid.org/0000-0002-8167-6146
Received: 04.12.2025 **Accepted:** 28.12.2025 **Publication Date:** 21.01.2026
Cite this article as: Barça F, Demir EB. Spinal outcomes and GAP score analysis following sequential total hip arthroplasty in hip-spine syndrome. J Turk Spinal Surg. 2026;37(1):9-16

the first and second procedures. A secondary aim is to assess sagittal balance-specifically global alignment and proportion (GAP) score-after each stage in the subgroup of patients for whom surgery was considered due to persistent lumbar symptoms. We hypothesize that spinal complaints will improve significantly following the first THA, but will show no further clinical improvement after contralateral THA.

MATERIALS AND METHODS

This single-center, observational clinical study, patient data were retrospectively evaluated after obtaining ethical committee approval from University of Health Sciences Türkiye, Ankara Etlik City Hospital's Ethics Committee (approval no: AEŞH-BADEK-2024-175, date: 28.02.2024). Written and verbal consent was obtained from all participants, and our study was conducted in accordance with the Declaration of Helsinki.

Data from patients who underwent THA in the Clinic of Orthopedics and Traumatology at University of Health Sciences Türkiye, Ankara Etlik City Hospital between September 2022 and October 2024 were reviewed. Inclusion criteria consisted of patients who had undergone bilateral THA and demonstrated radiological evidence of spinal degeneration (spinal stenosis, facet joint degeneration, lumbar disc degeneration, spondylolisthesis, or degenerative scoliosis) in the hospital imaging archive, along with clinical spinal or lumbar symptoms (radicular pain, low back pain, or neurogenic claudication). Exclusion criteria included THA performed for indications other than hip osteoarthritis (e.g., femoral neck fracture, femoral head avascular necrosis or trauma), bilateral THA performed less than 3 months apart, postoperative wound complications, periprosthetic fracture, postoperative hip dislocation, unwillingness to participate, or insufficient data. A total of 63 patients met the study criteria and were included in the final analysis. The study flowchart is presented in Figure 1.

Surgery and Follow-up Protocol

All patients were given antibiotics 1 hour before surgery (1 gram of cefazolin sodium for <80 kg, 2 grams for >80 kg). Patients were operated on the lateral decubitus position under spinal or general anesthesia, as determined by the anesthesiologists, using a standard posterolateral approach. Component placement was performed using the combined anteversion principle. The acetabular component was placed using the press-fit technique. Acetabular screw placement was performed according to the surgeon's preference. After performing an appropriate neck cut and medullary reaming, the femoral stem was placed using the press-fit technique. The operation was completed after intraoperative assessment of leg length, safe joint range of motion, and stability. Patients were allowed to bear weight as tolerated on the first postoperative day. Anticoagulation (enoxaparin) and compression socks were administered for deep vein thrombosis prophylaxis for one month. Patients were called for follow-up on the 15th day, 6th week, and 3rd month after surgery. After the 3-month follow-up, patients were scheduled for contralateral THA, and contralateral THAs were performed using the same protocol.

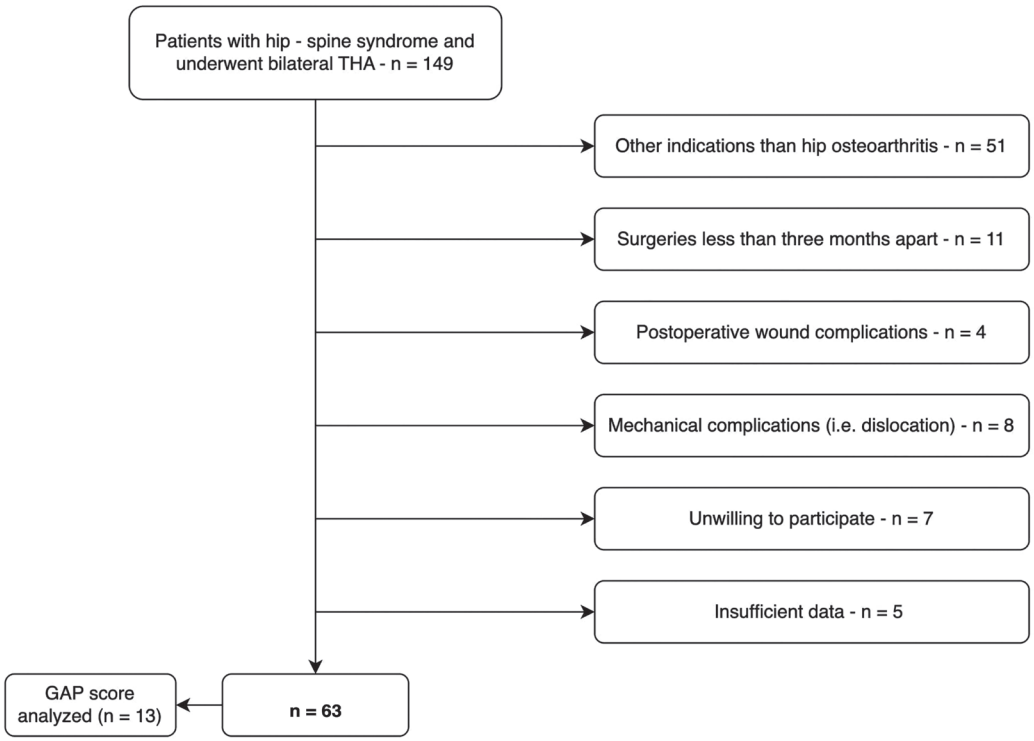

Figure 1. Study flowchart. THA: Total hip arthroplasty, GAP: Global alignment and proportion

Radiological and Clinical Evaluation

The demographic data (age, sex, body mass index) of all patients included in the study were recorded.

For clinical outcome assessment, the Turkish versions of the hip disability and osteoarthritis outcome score (HOOS), Roland-Morris disability questionnaire (RMDQ) and Oswestry disability index (ODI) were administered preoperatively, three months after the first THA, and three months after the second THA. HOOS is a 40-item questionnaire designed to evaluate pain, function, and quality of life in patients undergoing hip arthroplasty, covering pain, symptoms, activities of daily living, sports and recreation, and quality of life domains[11,12]. RMDQ is a 24-item questionnaire that measures limitations in daily activities secondary to low back pain[13,14]. ODI, consisting of ten subscales, is the most widely used and is considered the gold standard for assessing functional limitations related to back pain and lumbar spine degeneration[15,16].

Radiographic measurements were performed by two independent observers who were blinded to all clinical information. Measurements were obtained using the hospital's picture archiving and communication system (Innbiotec DICOM Viewer, Innbiotec Software, Dubai, UAE) on preoperative radiographs, as well as images acquired three months after the first THA and three months after the second THA. Leg length discrepancy (LLD) and pelvic obliquity were evaluated on standing anteroposterior pelvic radiographs. Additionally, GAP score was assessed in the subgroup of patients with persistent lumbar complaints who were scheduled for spinal surgery. LLD was measured as the vertical distance between two lines drawn parallel to the inter-teardrop line, each passing through the apex of a lesser trochanter (Figure 2)[17]. Pelvic obliquity was calculated by measuring the angle between the line connecting the highest points of the iliac crests and the horizontal plane (Figure 2)[18]. The GAP score, a system used to estimate the risk of mechanical complications following spinal deformity surgery, was calculated using patient age, pelvic incidence, sacral slope, L1-S1 lordosis, L4-S1 lordosis, and global tilt (Figure 3)[19].

Changes in HOOS and its subscale scores, as well as RMDQ and ODI scores, were compared between the preoperative period and after the first surgery, and between the first and second surgeries. Additionally, the relationship between these score changes and changes in LLD and pelvic obliquity was evaluated. In the subgroup in which GAP scores were measured, changes in GAP scores after each surgery were also analyzed.

Statistical Analysis

Statistical analyses were performed using Jamovi 2.0 (Jamovi Project, Sydney, Australia). Kolmogorov-Smirnov test was used to assess whether the data followed a normal distribution. Descriptive and outcome variables were presented as mean ± standard deviation or median (Q1-Q3), as appropriate, and categorical variables as frequencies and percentages. Differences between numerical variables were examined using the paired t-test or the Wilcoxon signed-rank test. Correlations between numerical variables were assessed using Spearman's rank correlation coefficient. Interrater reliability of the radiological measurements were evaluated with intraclass correlation coefficient (ICC), and ICC of the measurements were found to be 0.914. Mean values of two observations were used for analyses. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 63 patients (mean age 56.6±11.4 years, 49.2% male, body mass index =29.4±4.1) were included in the study. In 40 patients (63.5%), the right hip was operated on first.

Mean total HOOS scores improved from 32.7±5.8 to 60.9±5.8 after the first hip surgery (p<0.001) and to 91.7±2.3 after the second hip surgery (p<0.001). Significant improvements were also observed across all HOOS subscales following each procedure (p<0.001) (Table 1).

Median RMDQ scores were 17 (15-18.5) at baseline, 5 (4-11) after the first surgery, and 4 (3-10) after the second surgery, with both intervals showing statistically significant improvement (p<0.001 and p=0.004, respectively). Median ODI scores were 55 (47.5-65) at baseline, 15 (10-40) after the first surgery, and

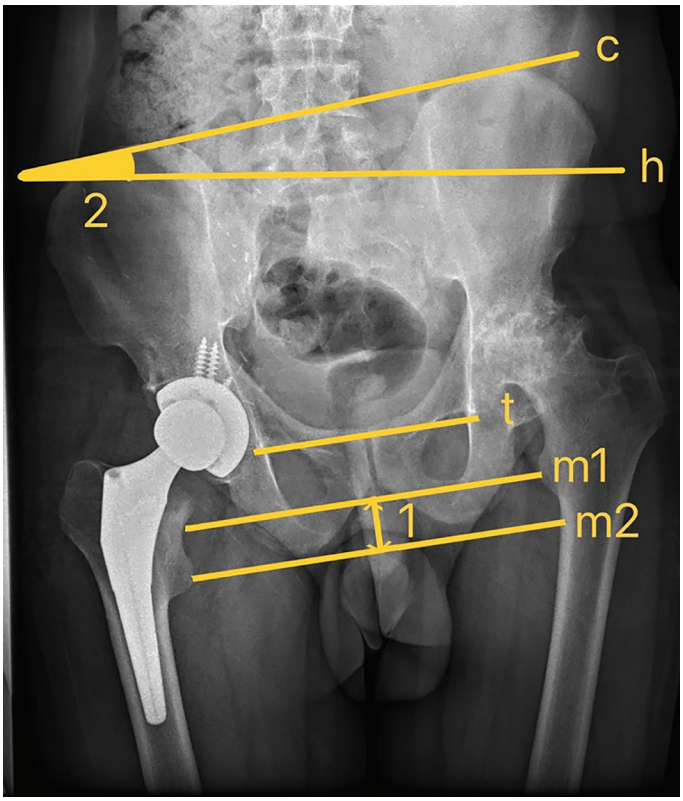

Figure 2. Measurement of coronal pelvic parameters on standing anteroposterior pelvis X-ray. Leg length discrepancy (1) was measured as the vertical distance between two lines drawn parallel to the inter-teardrop line (t), each passing through the apex of a lesser trochanter (m1 and m2). Pelvic obliquity (2) was calculated by measuring the angle between the line connecting the highest points of the iliac crests (c) and the horizontal plane (h)

10 (10-37.5) after the second surgery. Although there was a significant improvement after the first procedure (p<0.001), no significant additional improvement was observed after the second operation (p=0.161) (Figure 4, Table 1).

After the first surgery, RMDQ scores worsened in one patient (1.6%) and ODI scores worsened in four patients (6.3%). Following the second surgery, RMDQ scores worsened in 16 patients (25.4%) and ODI scores worsened in 14 patients (22.2%). Overall, the improvements in both RMDQ and ODI scores were significantly greater after the first surgery compared with the second (both p<0.001).

Spearman correlations between radiological changes (LLD and pelvic obliquity) and changes in disability scores (RMDQ and ODI) at both intervals (baseline to first surgery and first to second surgery) were small (|rho|<0.2) and not statistically significant (all p>0.05) (Table 2). Also, age did not correlate with changes in the HOOS, RMDQ and ODI scores (p>0.05 for all score changes).

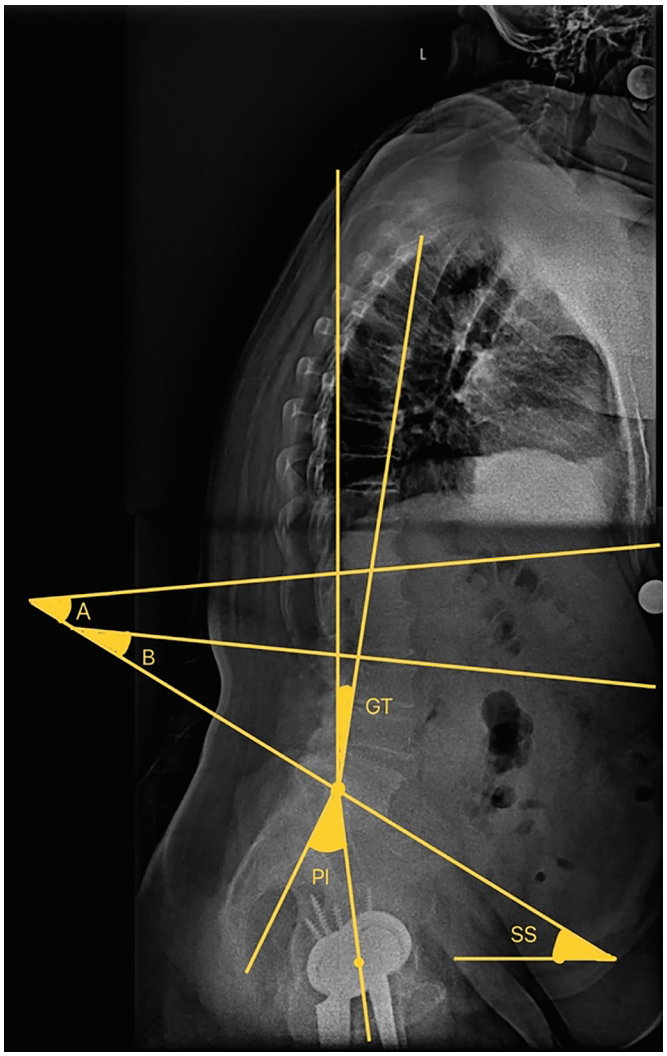

Figure 3. PI, SS, L1-S1 lordosis (A), L4-S1 lordosis (B), and GT were measured on sagittal spinal X-rays to assess global alignment and proportion score. PI: Pelvic incidence, SS: Sacral slope, GT: Global tilt

In the subgroup in which GAP scores were analyzed (n=13, mean age 66.4±7.5 years), GAP scores [median 3 (0-5)] did not change in any patient after either the first or second surgery. Also, no statistically significant differences in terms of measured sagittal parameters were observed (all p>0.05) (Table 1).

DISCUSSION

Our study evaluated early changes in lumbar symptoms following staged bilateral THA in patients with coexisting lumbar spinal findings. Significant improvement in lumbar complaints was observed after the first surgery, whereas no further improvement was noted after the second surgery. Moreover, a subset of patients experienced worsening lumbar scores following the second procedure. Improvements in lumbar scores were not associated with coronal radiographic parameters. In the subgroup assessed, sagittal balance remained unchanged after both hip surgeries.

The relationship between the spine and the pelvis has been a subject of investigation for a long time. Dubousset emphasized that the pelvis is a continuation of the spine and highlighted the concept of "pelvic vertebra"[20]. Jackson and Hales[21] identified strong correlations between pelvic parameters and spinal alignment. Following these descriptions, hip and spine surgeons have focused on the view that disorders occurring in the hip joint affect the lumbar alignment and degeneration, or that degeneration occurring in the spinal region affects the hip joint[22]. With aging and the associated degenerative process, patients' lumbar lordosis decreases, the sacral slope increases as a compensatory mechanism, and pelvic retroversion may develop. This situation may lead to the risk of posterior impingement and anterior dislocation after hip arthroplasty. For this reason, the development of implant designs such as dual-mobility hip replacement and the importance of acetabular cup placement in patients with lumbar degeneration are being focused on[22].

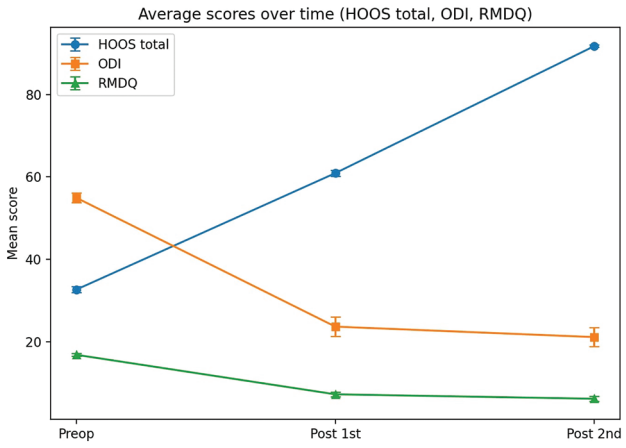

Figure 4. Changes in HOOS, RMDQ and ODI after first and second surgeries. HOOS: Hip disability and osteoarthritis outcome score, RMDQ: Roland-Morris disability questionnaire, ODI: Oswestry disability index

Table 1. Clinical scores and radiological results

	Baseline	After first surgery	Difference after first surgery	p-value	After second surgery	Difference after second surgery	p-value
HOOS	32.7±5.8	60.9±5.8	28.3±3.4	**<0.001 (1)**	91.7±3	30.8±4	**<0.001 (1)**
HOOS-sympt	39.3±7.5	66.8±8.3	27.5±6.6	**<0.001 (1)**	93.7±3	26.9±7.5	**<0.001 (1)**
HOOS-pain	35.9±7	58.8±8.2	22.9±1.4	**<0.001 (1)**	90.5±4	31.7±7.2	**<0.001 (1)**
HOOS-ADL	31.7±7.5	64.1±7	32.5±6.2	**<0.001 (1)**	93.2±1.8	29±7.3	**<0.001 (1)**
HOOS-sp/rec	34.4±8.2	56.4±11.8	22±8.6	**<0.001 (1)**	87.9±4	31.6±10.6	**<0.001 (1)**
HOOS-QoL	18.7±4.4	49.4±7.5	30.7±6	**<0.001 (1)**	90.2±5.4	40.8±11.6	**<0.001 (1)**
RMDQ	17 (15-18.5)	5 (4-11)	10 (8-12)	**<0.001 (2)**	4 (3-10)	1 (-0.5-3)	**0.004 (2)**
ODI	55 (47.5-65)	15 (10-40)	35 (25-42.5)	**<0.001 (2)**	10 (10-37.5)	0 (0-5)	0.161 **(2)**
Leg length discrepancy (mm)	8±8.5*	12.3±13.5	15.2±12.9	0.246 (1)	4.9±5.1*	12.9±12.6	0.399 (1)
Pelvic obliquity	2.2±2.1*	3.2±2.9	3±2.6	0.456 (1)	2±1.9*	2.7±2.9	0.170 (1)
Subgroup analysis (n=13)							
GAP score	3 (0-5)	-	-	-	3 (0-5)	0 (0-0)	-
Pelvic incidence	55.2 (45.8-66.3)	-	-	-	57.4 (44.2-67.4)	1.4 (-1.1-2.2)	0.340 (2)
Sacral slope	43.2 (39.3-46.1)	-	-	-	43.4 (39.7-44.6)	1 (-1.3-1.8)	0.463 (2)
L1-S1 lordosis	52.9 (41.4-61.3)	-	-	-	50.1 (40.6-59.7)	-2 (-2.2-0.8)	0.133 (2)
L4-S1 lordosis	33.4 (24.9-39.5)	-	-	-	33.4 (21.5-38.2)	-2 (-2.4-1)	0.147 (2)
Global tilt	13.5 (12.4-19.2)	-	-	-	14.1 (11.4-15.6)	-1-1 (-3.3--0.2)	0.094 (2)

*: Absolute values were used for mean ± standard deviation calculations, (1) Paired t-test, (2) Wilcoxon signed-rank test, HOOS: Hip disability and osteoarthritis outcome score, sympt: Symptoms, pain: Hip-related pain, ADL: Activities of daily living, sp/rec: Sports and recreation, QoL: Hip-related quality of life, RMDQ: Roland-Morris disability questionnaire, ODI: Oswestry disability index, GAP: Global alignment and proportion

Table 2. Spearman's correlation coefficients (rho) between changes in radiological parameters and changes in disability scores

	RMDQ score difference	p-value	ODI score difference	p-value
Leg length discrepancy after first surgery	-0.040	0.754	0.107	0.404
Pelvic obliquity after first surgery	0.191	0.132	0.118	0.356
Leg length discrepancy after second surgery	-0.154	0.226	0.013	0.916
Pelvic obliquity after second surgery	-0.080	0.532	-0.031	0.809

RMDQ: Roland-Morris disability questionnaire, ODI: Oswestry disability index

There is ongoing debate about which should be treated first in patients with HSS-hip or spine. It is argued that lumbar fusion prior to THA increases the risk of hip dislocation as it affects lumbar lordosis. It is claimed that gait and posture may improve after THA, which may reduce back pain due to changes in the load distribution on the spine. Andah et al.[23] reported that hip dislocation was not observed in patients with HSS syndrome who underwent THA first, while hip dislocation was observed in 11.9% of patients who underwent spinal surgery followed by THA. They also state that spinal surgery should be performed first, as radiculopathy and spinal stenosis findings may progress further if spinal surgery is performed following THA. Yang et al.[6] reported higher rates of dislocation, infection, revision surgery, and opioid usage in patients who underwent THA first. Although there is no clear consensus in the current literature, our own clinical experience suggests that performing THA first reduces lumbar complaints.

In patients with HSS syndrome who underwent bilateral THA, we observed a significant improvement in the patients' spinal-related clinical scores after the first THA, while we observed no significant change in the clinical scores after THA on the contralateral side. There are very few studies in the current literature on the stepwise treatment of bilateral hip pathologies in patients with HSS. Eguchi et al.[8] observed a reduction in back pain when THA was performed in patients with unilateral OA, but reported no change in back pain in patients who underwent THA due to bilateral OA. In contrast, Issani et al.[24] stated that bilateral THA in patients with HSS reduced the need for lumbar surgery, but unilateral THA reduced the need for lumbar surgery to a lesser extent.

They argued that this was because unilateral THA did not sufficiently correct spinopelvic alignment[24].

John et al.[25] reported that RMDQ scores decreased significantly within one year in their study examining dysfunctional low back pain after THA. Weng et al.[26] reported a significant improvement in postoperative RMDQ scores in patients with HSS syndrome who underwent unilateral THA. Vigdorchik et al.[27] reported that patients' symptomatic low back pain decreased after THA, and that the mean ODI score, which was 38 before surgery, was 17 after surgery. Can et al.[10] found a significant decrease in ODI scores after surgery in patients who underwent THA due to low back pain and Crowe IV developmental hip dysplasia. In our study, a significant decrease in RMDQ and ODI scores was observed after the first THA, while no improvement was observed in ODI scores in particular after the second THA.

A considerable amount of patients (nearly 25% of the study population) had worsened lumbar scores at short-term after the second THA. It was previously reported that the improvements of lumbar scores in unilateral hip osteoarthritis is more pronounced than in bilateral hip osteoarthritis after THA, and the authors of that study were attributed this finding to the correction of coronal alignment (specifically scoliosis)[8]. We investigated this by analyzing the correlation between several coronal alignment parameters and score changes, however we were unable to reach a significant correlation. Other factors that might have an influence on this finding include the possibility that hip-related pain may mask concomitant spinal symptoms[27]. Following hip surgery, the resolution of dominant hip pain may unmask pre-existing lumbar pathology, leading patients to perceive persistent or even worsened spinal symptoms despite technically successful arthroplasty. Also, due to the short-term follow-up (three months), dynamic recovery, such as restoration of gait, might be incomplete for resolution of lumbar symptoms.

Sagittal spinal balance has become an important subject for spinal surgeons in recent years[28]. While coronal alignment was previously emphasized after spinal surgery, sagittal spinal balance has become increasingly important due to reasons such as the increase in the number of surgeries, the occurrence of back and spine pain in patients after surgery, and the development of implant failure after surgery. For this reason, although many parameters are used, the use of the GAP score, a scoring system that aims to predict the risk of mechanical complications (post-junctional kyphosis, implant failure, etc.) after spinal surgery by evaluating the sagittal alignment of adult degenerative spines on an individual basis[19], is becoming widespread. For this purpose, we wanted to evaluate whether there was a change in the GAP score in patients with HSS syndrome who continued to have low back complaints after THA, and we observed that the GAP score was not affected by THA. We believe that our study is the first to evaluate this issue in the current literature.

Study Limitations

Among the limitations of our study, in addition to its retrospective nature, the time interval between the two surgeries and the follow-up period being as short as three months can be noted. Although we anticipated that three months would be sufficient time for patients to be aware of changes in their daily lives and that the significant improvement was observed in all scores within three months, studies demonstrate that changes in lumbar scores are more prominent in at least one year[4,29], therefore the results of this study should be considered as short-term. The same applies to spinopelvic parameters[30]. Studies with long-term follow-up are needed to interpret the adaptations in spinopelvic alignment and GAP scores.

According to the purpose of the study, spinal degenerative conditions were considered as a single phenomenon, but it should be noted that different spinal conditions might cause distinct symptomatology. Including the main cause of spinal symptoms would be beneficial to evaluate the effect of specific spinal condition (i.e., disc degeneration) on the spinal scores. However, most of the patients with HSS have overlapping spinal pathologies[31], and it would be challenging to isolate a single etiological factor and attribute clinical outcomes to a specific spinal pathology with sufficient reliability. Therefore, spinal degenerative conditions were evaluated collectively to reflect real-world clinical practice and the multifactorial nature of HSS.

Subgroup analysis of the GAP score was performed in a cohort with an extremely small sample size. Although these findings may provide preliminary insight into potential GAP score changes following THA, they should be interpreted with caution, and no definitive conclusions can be drawn. Further studies with larger sample sizes are warranted to validate these findings and to better elucidate the relationship between THA and spinopelvic alignment as assessed by the GAP score.

The patients were not operated on by a single surgeon, and the brands, models, and sizes of the hip prostheses were not uniform. This heterogeneity limits the ability to fully control for surgery-related factors. Although this issue was partially addressed by excluding patients with surgical complications, variations in surgeon experience, implant selection, and technical details of the procedures may still have influenced both functional and radiological outcomes.

CONCLUSION

In patients with HSS undergoing staged bilateral THA using a hip-first approach, a marked improvement in lumbar spinal symptoms was observed after the first procedure in short-term, however, this improvement did not persist to the same extent following the second procedure, with a subset of patients demonstrating worsening lumbar scores postoperatively. No significant association was identified between changes in

lumbar scores and coronal pelvic radiographic parameters. Furthermore, in the analyzed subgroup, GAP scores remained unchanged after both procedures, and no significant differences could be detected in sagittal alignment parameters.

Ethics

Ethics Committee Approval: This single-center, observational clinical study, patient data were retrospectively evaluated after obtaining ethical committee approval from University of Health Sciences Türkiye, Ankara Etlik City Hospital's Ethics Committee (approval no: AEŞH-BADEK-2024-175, date: 28.02.2024).
Informed Consent: Written and verbal consent was obtained from all participants.

Acknowledgments

The authors wish to thank MD Mutlu Akdoğan, and MD Atıl Atilla for mentorship throughout the study, and MD Mert Uçak, and MD Mustafa Kaan Tüzün for providing radiological measurements.

Footnotes

Authorship Contributions

Surgical and Medical Practices: F.B., E.B.D., Concept: F.B., Design: F.B., Data Collection or Processing: E.B.D., Analysis or Interpretation: F.B., Literature Search: E.B.D., Writing: F.B., E.B.D.
Conflict of Interest: No conflict of interest was declared by the authors.
Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Offierski CM, MacNab I. Hip-spine syndrome. Spine (Phila Pa 1976). 1983;8:316-21.
2. Younus A, Kelly A. Hip spine syndrome - a case series and literature review. Interdisciplinary Neurosurgery. 2021;23:100960.
3. Devin CJ, McCullough KA, Morris BJ, Yates AJ, Kang JD. Hip-spine syndrome. J Am Acad Orthop Surg. 2012;20:434-42.
4. Zhang SE, Anatone AJ, Figgie MP, Long WJ, Della Valle AG, Lee GC. Spine or hip first? Outcomes in patients undergoing sequential lumbar spine or hip surgery. J Arthroplasty. 2023;38:s114-8.e2.
5. Huppert A, Ambrosio L, Nwosu K, Pico A, Russo F, Vadalà G, et al. Previous lumbar spine fusion increases the risk of dislocation following total hip arthroplasty in patients with hip-spine syndrome: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2024;25:732.
6. Yang DS, Li NY, Mariorenzi MC, Kleinhenz DT, Cohen EM, Daniels AH. Surgical treatment of patients with dual hip and spinal degenerative disease: effect of surgical sequence of spinal fusion and total hip arthroplasty on postoperative complications. Spine (Phila Pa 1976). 2020;45:e587-93.
7. Diebo BG, Alsoof D, Balmaceno-Criss M, Daher M, Lafage R, Passias PG, et al. Hip osteoarthritis in patients undergoing surgery for severe adult spinal deformity: prevalence and impact on spine surgery outcomes. Bone Joint Surg Am. 2024;106:1171-80.
8. Eguchi Y, Iida S, Suzuki C, Shinada Y, Shoji T, Takahashi K, et al. Spinopelvic alignment and low back pain after total hip replacement arthroplasty in patients with severe hip osteoarthritis. Asian Spine J. 2018;12:325-34.
9. Morimoto T, Kobayashi T, Tsukamoto M, Yoshihara T, Hirata H, Toda Y, et al. Sagittal-spinopelvic alignment improves in patients with bilateral highly dislocated hip (crowe type IV) after subtrochanteric shortening total hip arthroplasty: a retrospective radiographic study. Medicine (Baltimore). 2024;103:e36966.
10. Can A, Erdoğan F, Yontar NS, Övül Erdoğan A, Erdem MN, Sarıkaya İA. Spinopelvic alignment does not change after bilateral total hip arthroplasty in patients with bilateral crowe type-IV developmental dysplasia of the hip. Acta Orthop Traumatol Turc. 2020;54:583-6.
11. Nilsdotter AK, Lohmander LS, Klässbo M, Roos EM. Hip disability and osteoarthritis outcome score (HOOS)--validity and responsiveness in total hip replacement. BMC Musculoskelet Disord. 2003;4:10.
12. Gökşen A, Çaylak R, Çekok FK, Kahraman T. Translation, cross-cultural adaptation, reliability, and convergent and known-group validity of the Turkish full version of the hip disability and osteoarthritis outcome score in patients with hip osteoarthritis. Arch Rheumatol. 2023;39:180-93.
13. Roland M, Morris R. A study of the natural history of back pain. Part I: development of a reliable and sensitive measure of disability in low-back pain. Spine (Phila Pa 1976). 1983;8:141-4.
14. Küçükdeveci AA, Tennant A, Elhan AH, Niyazoglu H. Validation of the Turkish version of the Roland-Morris disability questionnaire for use in low back pain. Spine (Phila Pa 1976). 2001;26:2738-43.
15. Fairbank JC, Pynsent PB. The oswestry disability index. Spine (Phila Pa 1976). 2000;25:2940-52; discussion 2952.
16. Yakut E, Düger T, Oksüz C, Yörükan S, Ureten K, Turan D, et al. Validation of the Turkish version of the Oswestry disability index for patients with low back pain. Spine (Phila Pa 1976). 2004;29:581-5; discussion 585.
17. Inoue D, Kabata T, Kajino Y, Taga T, Hasegawa K, Yamamoto T, et al. The influence of surgical approach on postoperative pelvic tilt after total hip arthroplasty. Eur J Orthop Surg Traumatol. 2017;27:1131-8.
18. Osebold WR, Mayfield JK, Winter RB, Moe JH. Surgical treatment of paralytic scoliosis associated with myelomeningocele. J Bone Joint Surg Am. 1982;64:841-56.
19. Yilgor C, Sogunmez N, Boissiere L, Yavuz Y, Obeid I, Kleinstück F, 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. J Bone Joint Surg Am. 2017;99:1661-72.
20. Dubousset J. The pelvic vertebra, the cephalic vertebra and the concept of the chain of balance. In: Vital J, Cawley D. (eds.). Spinal anatomy. Springer, Cham. 2020.
21. Jackson RP, Hales C. Congruent spinopelvic alignment on standing lateral radiographs of adult volunteers. Spine (Phila Pa 1976). 2000;25:2808-15.
22. Nessler JM, Malkani AL, Sachdeva S, Nessler JP, Westrich G, Harwin SF, et al. Use of dual mobility cups in patients undergoing primary total hip arthroplasty with prior lumbar spine fusion. Int Orthop. 2020;44:857-62.
23. Andah G, Hume E, Nelson C, Lee GC. Does timing of lumbar fusion affect dislocation rate after total hip arthroplasty? J Orthop. 2021;27:145-8.
24. Issani A, Karakash WJ, Lindgren A, Rusu D, Avetisian H, Athari M, et al. Long-term impact of total hip arthroplasty on subsequent lumbar spine surgery in patients with hip-spine disease: a nationwide analysis of risk factors and outcomes. Global Spine J. 2025:21925682251387072.
25. John AT, Samuel S, Livingston A, Matthai T, Daniel AJ. A prospective cohort study on the effect of low back pain in patients undergoing total hip arthroplasty. Hip Int. 2025;35:550-5.
26. Weng W, Wu H, Wu M, Zhu Y, Qiu Y, Wang W. The effect of total hip arthroplasty on sagittal spinal-pelvic-leg alignment and low back pain in patients with severe hip osteoarthritis. Eur Spine J. 2016;25:3608-14.
27. Vigdorchik JM, Shafi KA, Kolin DA, Buckland AJ, Carroll KM, Jerabek SA. Does low back pain improve following total hip arthroplasty? J Arthroplasty. 2022;37:s937-40.

28. Le Huec JC, Thompson W, Mohsinaly Y, Barrey C, Faundez A. Sagittal balance of the spine. Eur Spine J. 2019;28:1889-905.
29. Sullivan TB, Lynch CP, Cha EDK, Geoghegan CE, Jadczak CN, Mohan S, et al. Impact of lower extremity arthroplasty on improvement of quality-of-life outcomes following lumbar fusion. Int J Spine Surg. 2022;16:1016-22.
30. Innmann MM, Verhaegen JCF, Reichel F, Schaper B, Merle C, Grammatopoulos G. Spinopelvic characteristics normalize 1 year after total hip arthroplasty: a prospective, longitudinal, case-controlled study. J Bone Joint Surg Am. 2022;104:675-83.
31. Aaen J, Austevoll IM, Hellum C, Storheim K, Myklebust TÅ, Banitalebi H, et al. Clinical and MRI findings in lumbar spinal stenosis: baseline data from the NORDSTEN study. Eur Spine J. 2022;31:1391-8.