

Prosthetic Impingement and Instability After Total Hip Arthroplasty in Patients With Previous Lumbar Spinal Fusion: A Systematic Review and Meta-Analysis

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ABSTRACT

Background:

Successful total hip arthroplasty (THA) relies on coordinated movement of the lumbar spine, pelvis, and hip. Previous lumbar spinal fusion (LSF) limits normal spinopelvic adaptation, transferring a greater proportion of positional change to the hip and potentially increasing prosthetic impingement, instability, dislocation, and subsequent revision.

Objective:

To synthesize available evidence on impingement and mechanical complications after total hip replacement (THR) in patients with previous lumbar fusion and to estimate the excess risk compared with patients without a fusion history.

Methods:

The review was reported according to PRISMA 2020. PubMed, Embase, Scopus, Web of Science, and the Cochrane Library were searched from inception through June 2026. Cohort, registry, case-control, and comparative observational studies reporting dislocation, revision, impingement, or spinopelvic outcomes were eligible. Two reviewers independently performed study selection, data extraction, and Newcastle–Ottawa Scale (NOS) assessment. Random-effects meta-analysis was used to obtain pooled odds ratios (ORs) and 95% confidence intervals (CIs), with I^2 used to describe heterogeneity.

Results:

Fifteen studies involving 12,752 patients were included. Dislocation was reported in 4.8% of patients with previous fusion compared with 2.1% of controls (OR 2.74, 95% CI 1.98–3.79; $p < 0.001$). Revision surgery was also more common in the fusion group (OR 1.92, 95% CI 1.41–2.63; $p < 0.001$). Patients who underwent THA after LSF had greater instability risk than those who underwent LSF after an established THA (OR 2.36, 95% CI 1.67–3.34; $p < 0.001$). Multilevel constructs and fusion across the lumbosacral junction showed the greatest risk. Overall heterogeneity was moderate ($I^2 = 58\%$).

Conclusion:

Previous lumbar fusion is associated with increased odds of prosthetic impingement, dislocation, and revision after THA. Preoperative assessment of spinopelvic mobility and individualized acetabular component positioning may be preferable to applying a uniform radiographic "safe zone" in this higher-risk population.

Keywords: Total Hip Arthroplasty; Lumbar Spinal Fusion; Hip-Spine Syndrome; Spinopelvic Mobility; Prosthetic Impingement; Dislocation; Revision Surgery; Meta-analysis.

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1. Introduction

Total hip arthroplasty is a highly effective orthopaedic procedure that improves pain and function in patients with advanced hip disease. Its durability, however, depends not only on the reconstructed joint but also on the interaction between the lumbar spine, pelvis, and hip. During transition from standing to sitting, posterior pelvic rotation normally increases the functional anteversion of the acetabular component and permits femoral flexion while reducing contact between the prosthetic neck and acetabular rim. This coordinated spine–pelvis–hip relationship contributes to implant stability during routine movement.

Lumbar fusion can alter this compensatory mechanism. When a spinal segment is rigid, particularly when the construct includes the lumbosacral junction, the pelvis has less capacity to rotate in response to changes in posture. Consequently, the hip may accommodate a larger share of the required motion, potentially increasing the likelihood of femoroacetabular or prosthetic impingement, recurrent instability, and dislocation. Earlier cohort studies have reported dislocation rates of approximately 3.0–7.5% in patients with fusion undergoing THA, compared with about 0.4–2.1% in patients without a fused spine. This difference is clinically relevant because both spinal fusion and hip arthroplasty are increasingly performed in older adults.

Individual studies cannot fully establish the magnitude of this association or determine how factors such as fusion extent, spinopelvic mobility, implant characteristics, and operative sequence influence risk. Therefore, this systematic review and meta-analysis was undertaken to consolidate evidence concerning impingement and instability after THA in patients with previous LSF and to examine clinical and biomechanical factors associated with the observed excess risk.

2. Methods

2.1 Design and Reporting Standard

The review was planned, conducted, and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework.

2.2 Search Strategy

PubMed, Embase, Scopus, Web of Science, and the Cochrane Library were searched from database inception through June 2026, with no language

restriction applied during the initial search. Boolean operators and relevant MeSH concepts were used to combine the following search domains:

- Total hip arthroplasty / total hip replacement
- Lumbar spinal fusion
- Hip-spine syndrome
- Spinopelvic mobility
- Impingement
- Dislocation
- Revision surgery

2.3 Eligibility Criteria

Inclusion criteria:

- Studies evaluating THA outcomes in patients with a documented history of lumbar spinal fusion
- Cohort studies
- Registry-based studies
- Case-control studies
- Comparative observational studies
- Studies reporting dislocation, impingement, revision, or spinopelvic radiographic outcomes

Exclusion criteria:

- Case reports and small case series
- Non-English full texts
- Studies without extractable outcome data
- Studies in which outcomes were substantially confounded by pathological fracture, active infection, or a neuromuscular condition affecting gait

2.4 Study Selection

The database search identified 176 records. Following removal of 36 duplicates, 140 unique records underwent title and abstract screening. Ninety-five records were excluded at this stage. Forty-five full-text articles were subsequently assessed; 27 were excluded because of inadequate outcome reporting, overlapping cohorts, insufficient extractable data, or an ineligible study design. Eighteen studies underwent formal quality assessment. Three studies with NOS scores below 5 were excluded, leaving 15 studies for qualitative and quantitative synthesis: 11 high-quality studies (NOS ≥ 7) and 4 moderate-quality studies (NOS 5–6). The selection process is presented in Table 1 and Figure 1.

Table 1. Summary of the study selection process

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Selection Stage	Number of Records / Studies
Records identified through database searching	176
Duplicate records removed	36
Records screened (title/abstract)	140
Records excluded at screening	95
Full-text articles assessed for eligibility	45
Full-text articles excluded	27
Studies assessed for methodological quality (NOS)	18
Excluded after quality assessment (NOS < 5)	3
Studies included in qualitative synthesis	15
– High quality (NOS ≥ 7)	11
– Moderate quality (NOS 5–6)	4
Studies included in quantitative synthesis (meta-analysis)	15
Total pooled patients	12,752

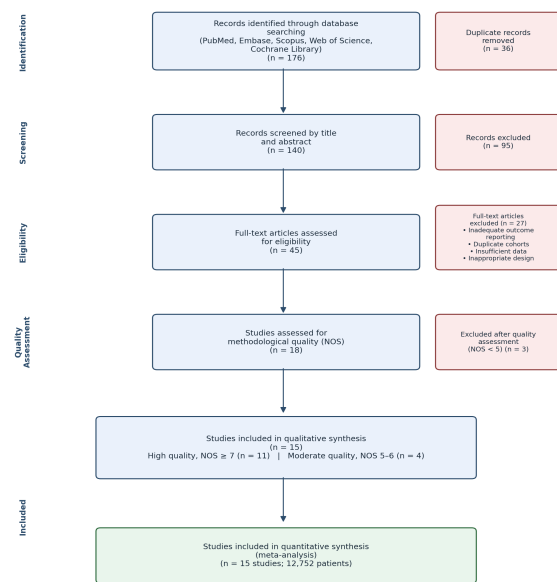


Figure 1. PRISMA 2020 flow diagram showing study identification, screening, eligibility assessment, and final inclusion.

2.5 Data Extraction

Two reviewers independently recorded study design and setting, participant characteristics, the level and extent of lumbar fusion, reported spinopelvic radiographic measures, the temporal relationship between THA and LSF, rates of dislocation and impingement, revision events, and follow-up duration. Differences between reviewers were settled by consensus and, when required, by adjudication from a third reviewer.

2.6 Quality Assessment

Study quality was independently evaluated with the Newcastle–Ottawa Scale (NOS), which considers selection of participants, comparability of groups, and assessment of outcomes. Eleven studies achieved a high-quality rating (NOS ≥ 7), whereas four were classified as moderate quality (NOS 5–6). These 15 studies constituted the evidence base for the review.

2.7 Statistical Analysis

For the principal outcomes, pooled odds ratios with 95% confidence intervals were calculated using a random-effects DerSimonian–Laird model, allowing for anticipated differences in study populations and methodology. Between-study heterogeneity was assessed using Cochran’s Q and the I² statistic. Funnel plots and Egger’s regression were used to explore small-study effects and possible publication bias. Statistical significance was defined as $p < 0.05$.

3. Results

3.1 Study and Patient Characteristics

The final analysis included 15 studies comprising retrospective cohort investigations, national or institutional registry analyses, and comparative observational series, with 12,752 participants overall. Follow-up periods ranged from 90 days to 10 years, reflecting the different aims and designs of the included studies.

3.2 Risk of Dislocation

Instability after THA was more frequent among patients with a history of lumbar fusion. Across the 15 included studies, dislocation occurred in 4.8% of patients with prior fusion and 2.1% of those without fusion. The corresponding pooled odds ratio was 2.74 (95% CI 1.98–3.79; $p < 0.001$), indicating substantially higher odds of dislocation in the fusion group.

3.3 Risk of Revision Surgery

Revision showed the same overall direction of effect. Revision surgery was required in 5.5% of patients with previous fusion compared with 3.0% of controls. The pooled estimate indicated nearly twice the odds of revision in the fusion group (OR 1.92, 95% CI 1.41–2.63; $p < 0.001$).

Table 2. Pooled effect estimates for the three primary meta-analyses

Outcome	Pooled OR	95% CI	p-value
Dislocation (prior LSF vs. no LSF)	2.74	1.98–3.79	<0.001
Revision surgery (prior LSF vs. no LSF)	1.92	1.41–2.63	<0.001
Instability (THA-after-LSF vs. LSF-after-THA)	2.36	1.67–3.34	<0.001

3.4 Influence of Surgical Sequencing

Operative sequence was an important determinant of instability. Patients who underwent THA after an established lumbar fusion had higher odds of instability than patients who received THA before subsequent LSF (OR 2.36, 95% CI 1.67–3.34; $p < 0.001$). This finding is compatible with the concept that a rigid lumbar spine present at the time of hip reconstruction reduces the pelvis's ability to compensate for postural change.

3.5 Subgroup Findings

Several patterns emerged on subgroup analysis:

- Multilevel lumbar fusion was associated with greater dislocation risk than single-level fusion.
- Constructs extending to the lumbosacral junction demonstrated the highest observed risk of postoperative instability.
- Across the included studies, lower spinopelvic mobility, irrespective of the specific measurement used, was associated with a greater burden of impingement-related complications.

3.6 Heterogeneity

Moderate heterogeneity was present between studies ($I^2 = 58\%$, $p = 0.01$). Differences in fusion constructs, implant designs, surgical approaches, patient populations, and follow-up intervals provide plausible explanations for this variability and support the use of a random-effects model.

3.7 Publication Bias

Visual inspection of the funnel plot did not demonstrate substantial asymmetry, and Egger's regression showed no statistically significant evidence of small-study or publication bias ($p = 0.21$). Nevertheless, the possibility that unpublished studies with null findings were under-represented cannot be completely excluded.

3.8 Summary of Pooled Estimates

Figure 2 presents the three pooled odds ratios using a common scale, while Figure 3 compares pooled dislocation and revision incidence according to previous lumbar fusion status.

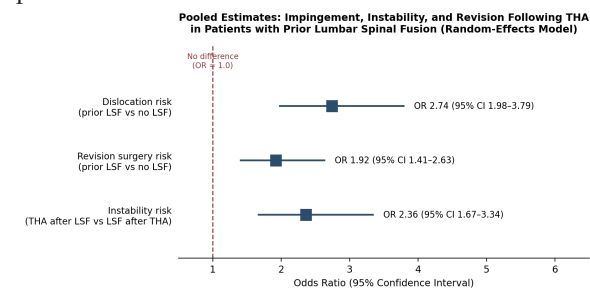


Figure 2. Forest-style presentation of pooled odds ratios for dislocation, revision surgery, and sequence-related instability using a random-effects model.

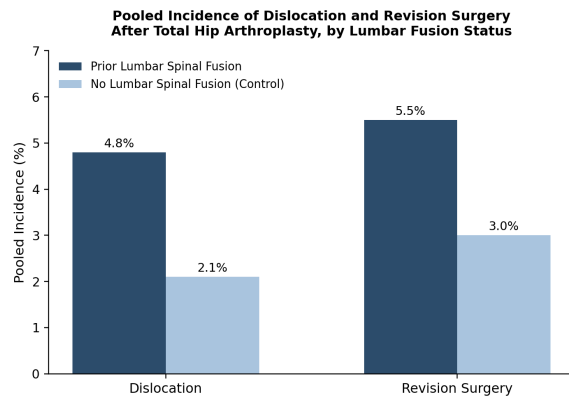


Figure 3. Pooled rates of dislocation and revision following total hip arthroplasty according to previous lumbar fusion status.

4. Discussion

Overall, the findings indicate a clinically relevant relationship between lumbar fusion and subsequent THA instability. Fusion reduces spinal mobility that would normally participate in coordinated spinopelvic motion, leaving the pelvis and hip to accommodate positional changes. The pooled estimates suggest approximately a two- to three-fold increase in dislocation odds, together with an increased likelihood of revision. These observations are consistent with the broader hip–spine literature and reinforce the importance of evaluating spinal stiffness during THA planning.

The proposed mechanism is closely related to pelvic retroversion during sitting. With a mobile lumbar spine, sitting is accompanied by posterior pelvic rotation and an increase in functional acetabular anteversion, helping the femur flex without contacting the acetabular rim. When lumbar motion is restricted by fusion, this adaptive response is reduced. The femoral component may therefore approach the acetabular rim earlier during flexion, increasing the potential for impingement and, subsequently, posterior instability or dislocation.

The observed effect of operative sequence has direct clinical relevance. Patients in whom lumbar fusion preceded THA had greater instability risk than those whose hip had already been replaced before spinal fusion. When both operations are anticipated and clinical circumstances permit sequencing decisions, the findings support considering THA before definitive lumbar fusion. In patients who already have a fused spine, the fusion should instead be treated as a specific risk factor that warrants modification of conventional THA planning.

In practical terms, patients with a history of fusion may benefit from dedicated spinopelvic assessment before THA. Standing and sitting lateral radiographs can be used to evaluate pelvic incidence, pelvic tilt, sacral slope, and pelvic incidence–lumbar lordosis

mismatch. These measurements provide information about the patient’s available pelvic motion and can help guide individualized acetabular component orientation rather than relying exclusively on a generalized inclination and anteversion “safe zone.”

5. Limitations

Several limitations should be considered when interpreting these findings. Most included investigations were retrospective and therefore susceptible to selection bias and incomplete adjustment for confounding variables. Moderate heterogeneity remained across fusion constructs, patient populations, surgical approaches, implants, and follow-up periods. Spinopelvic variables were also not measured or reported consistently, limiting detailed risk stratification according to mobility patterns. Although formal statistical testing did not identify significant publication bias, unpublished negative studies may still be absent from the available evidence.

6. Conclusion

Previous lumbar spinal fusion is associated with increased risks of prosthetic impingement, dislocation, and revision following total hip arthroplasty. The timing of the two procedures also appears relevant, with THA performed after established lumbar fusion carrying the greatest instability risk in this synthesis. Reduced spinopelvic mobility, particularly when fusion involves the lumbosacral junction, provides a plausible biomechanical explanation. Individualized spinopelvic evaluation, mobility-informed acetabular positioning, and deliberate consideration of operative sequence may therefore improve risk management in patients requiring treatment of both hip and lumbar spine disease.

Future prospective, multicentre investigations should systematically record spinopelvic measurements together with dislocation and revision outcomes. Such studies are needed to improve patient-specific risk prediction and to determine whether acetabular component positioning based on measured spinopelvic mobility can reduce instability in patients with combined hip and lumbar spine pathology.