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Total Hip Arthroplasty in Patients With Previous Lumbar Fusion Surgery: Are There More Dislocations and Revisions?

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ABSTRACT

Background: The purpose of this study was to determine whether the risk of dislocation and/or revision following THA is increased in patients with a history of prior lumbar fusion given the alterations in dynamic pelvic motion following LSF.

Methods: A total of 62,387 patients (5% Medicare part B claims database) were identified from 1997 to 2014 with primary THA. From this group, 1809 patients (2.9%) were stratified to identify those with prior lumbar fusion within 5 years of primary THA to compare risk of dislocation and revision with those without lumbar fusion. Multivariate cox regression analysis was performed adjusting for age, socioeconomic status, race, census, region, gender, Charlson score, preexisting conditions, and type of fusion.

Results: Between years 2002 and 2014, there was a 293% increase in the number of patients with prior lumbar fusion undergoing THA. Prevalence of hip dislocation in patients with lumbar fusion before THA was 7.4% compared to 4.8% without fusion, $P < .001$. There was an 80% increase in dislocation in the fusion group at 6 months, 71% at 1 year, and 60% at 2 years. There was a 48% increased risk of failure leading to revision hip surgery in patients with fusion at 6 months, 41% at 1 year, and 47% at 2 years. Dislocation was the most common mode of failure leading to revision in both the fusion group (20.8%) and the nonfusion group (16%).

Conclusion: Results of this study demonstrate that lumbar fusion before THA is an independent risk factor for dislocation leading to increased risk of revision THA.

The number of patients undergoing total hip arthroplasty (THA) continues to increase, with the Centers for Disease Control and Prevention (CDC) estimating nearly 330,000 performed each year in the United States as of 2010 [1]. In 2008, over 413,000 spinal fusion surgeries were performed [2]. Increasing numbers of patients are undergoing both lumbar spine fusion (LSF) and THA. Each procedure alone effectively alleviates patients' symptoms, but concerns have arisen regarding increased complication rates in those patients who have undergone both operations [3].

The goal of LSF is to reduce motion in those segments involved in order to relieve patients' symptoms due to stenosis, instability, radiculopathy, or any combination thereof. Creating rigidity in the lumbar spine, or an altered sagittal plane balance, and abnormal pelvic parameters can lead to proximal junctional kyphosis and these factors may contribute to early failure of THA in this patient population [4]. Patients undergoing primary THA who had previously undergone LSF may not be able to safely accommodate THA implants in the same "safe zone" position as those patients with their native or normal lumbar spine, as described by Lewinnek et al [5]. The overall decreased lumbar flexibility following lumbar fusion and its effect on pelvic and hip biomechanics warrants

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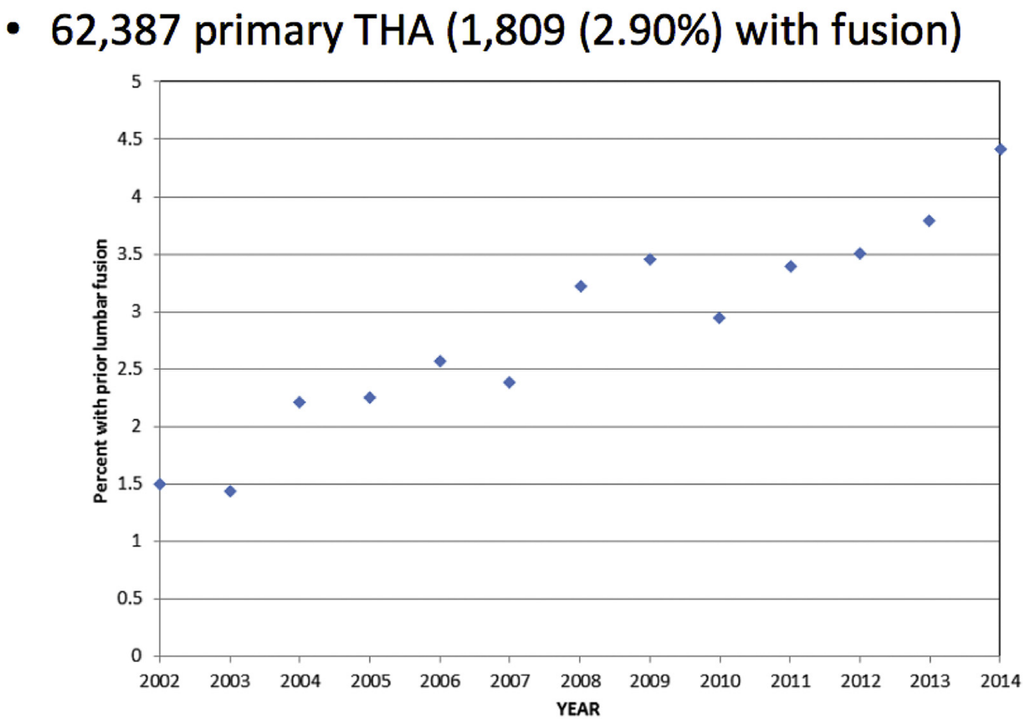

Fig. 1. Patient cohort. THA, total hip arthroplasty.

increased investigation and vigilance before considering THA candidacy and surgical planning.

The goals of this study are to investigate the prevalence of patients with THA within 5 years of undergoing prior LSF in the Medicare population and compare the risk of dislocation and revision in THA patients with and without prior LSF.

Materials and Methods

We retrospectively reviewed 5% Medicare Part B claims data from 1997 to 2014 to identify patients who underwent primary THA (Current Procedural Terminology [CPT] codes 27130 and 27132) between 2002 and 2014, leaving 5 years prior for review of those with previous LSF. The following patients were excluded from the analysis: (1) younger than 65 years; (2) non-US residents; (3) enrolled in a Health Maintenance Organization (HMO); and (4) not enrolled in both Parts A and B. The younger patients were excluded due to their enrollment in Medicare for confounding reasons, such as physical disabilities, end-stage renal disease, and ALS. The remaining exclusion criteria were applied due to the incomplete claim history for those patients. We then stratified the data to identify those patients who had undergone LSF (CPT codes 22558, 22612, 22630, and 22633) within 5 years before THA, resulting in a cohort of 1809 patients (out of 62,387 primary THA or 2.9%). CPT codes 22585, 22614, 22632, and 22634 were used to identify each additional spine levels treated. Post-THA dislocation was identified using 27250, 27252, 27253, 27254, 27265, and 27266, while revision surgery was identified 27134, 27137, and 27138.

A multivariate Cox regression was used to compare the risk of dislocation and revision following primary THA between those patients who had LSF in the 5 years before THA and those who did not. The analysis was adjusted for age, socioeconomic status (Medicare buy-in), race, census region, gender, year THA performed, Charlson comorbidity score, preexisting conditions (within 12 months before THA including diabetes, obesity, and smoking), history of prior LSF within 5 years, type of lumbar fusion (anterior lumbar interbody fusion, posterior lumbar interbody fusion, transforaminal lumbar interbody fusion, 360° fusion, single-incision 360 fusion), and number of fusion interspaces.

Results

We identified 62,387 Medicare patients who met the inclusion criteria and underwent primary THA between 2002 and 2014, which extrapolated to 1,247,740 Medicare patients having the procedure in this time interval. We found that 1809 (3%) of the 62,387 THA patients had previously undergone LSF within 5 years before THA. Between 2002 and 2014, there was a 293% increase in the number of patients with LSF undergoing THA (Fig. 1). Age ($P < .001$), Charlson score ($P < .001$), prior LSF ($P < .001$), Medicare buy-in ($P < .001$), census region ($P < .001$), year of surgery ($P < .001$), race ($P = .013$), and gender ($P = .011$) were identified as risk factors for dislocation in all THA patients within 5 years postoperatively, regardless of previous LSF or not (Table 1). The prevalence of dislocation in patients with prior LSF was 7.4%, compared to 4.8% in patients without previous LSF, $P < .001$. There was an 80% increased risk of dislocation in the LSF group at 6 months, 71% at 1 year, 60% at 2 years, 67% at 5 years, and 72% at 10 years ($P < .001$ for all time periods; Fig. 2).

The prevalence of revision in patients with prior LSF was 6.9%, compared to 4.6% in patients without previous LSF. There was a 48% increase in the risk of revision in LSF group at 6 months ($P = .007$), 41% at 1 year ($P = .012$), 47% at 2 years ($P = .002$), 53% at 5 years ($P < .001$), and 55% at 10 years ($P < .001$; Fig. 3). Age ($P = .021$), Charlson score ($P < .001$), prior LSF ($P < .001$), Medicare buy-in ($P = .017$), race ($P = .003$), census region ($P < .001$), and smoking ($P = .049$) were identified as risk factors for revision in all THA patients within 5 years postoperatively, regardless of LSF history (Table 2). For the fusion patients, the type of lumbar fusion was an independent risk factor for revision surgery ($P < .001$), but not found to be a risk factor for dislocation ($P = .552$). The number of segments fused was also not a risk factor for dislocation ($P = .098$) or revision ($P = .468$). Dislocation was

Table 1
Risk Factors for Dislocation Within 5-y of Primary THA.

Covariate	Covariate *P* Value	Level	Adjusted HR (95% Confidence Interval)	Level *P* Value
Age	<.001	65-69	Reference	
		70-74	0.95 (0.83-1.09)	.487
		75-79	0.99 (0.87-1.13)	.866
		80-84	1.11 (0.96-1.28)	.147
		85+	1.32 (1.12-1.54)	<.001
Charlson score	<.001	0	Reference	
		1-2	1.31 (1.19-1.45)	<.001
		3-4	1.59 (1.40-1.81)	<.001
		5+	2.20 (1.88-2.57)	<.001
Diabetes	.207	Yes vs no	0.94 (0.85-1.04)	.207
Prior fusion	<.001	Yes vs no	1.67 (1.35-2.06)	<.001
Medicare buy-in	<.001	Yes vs no	1.58 (1.38-1.81)	<.001
Obesity	.881	Yes vs no	1.01 (0.89-1.14)	.881
Race	.013	White	Reference	
		Black	0.79 (0.64-0.98)	.031
		Other	0.67 (0.47-0.97)	.034
Region	<.001	South	Reference	
		Midwest	0.79 (0.64-0.98)	<.001
		Northeast	0.87 (0.78-0.97)	.016
		West	0.80 (0.70-0.91)	<.001
Sex	.011	Female vs male	1.12 (1.03-1.22)	.011
Smoking	.361	Yes vs no	1.06 (0.94-1.19)	.361
Year	<.001		0.95 (0.94-0.96)	<.001

THA, total hip arthroplasty; HR, hazard ratio.

the most common mode of failure leading to revision in both the fusion group (20.8%) and the nonfusion group (16%; Table 3).

Discussion

The number of patients undergoing primary THA following prior LSF increased by 293% over the study period. With the significant increase in the number of patients with prior LSF undergoing THA and the added risk of dislocation in this group, a better understanding of the spinopelvic pathology and solutions to address this problem is necessary. The increased incidence of LSF has been somewhat parallel to the rise of primary hip and knee arthroplasty volumes over the past decade given the increased lifespan of our elderly. At present, approximately 4.5% of Medicare patients have a prior LSF within 5 years of their primary hip arthroplasty. In this study, we found patients undergoing THA within 5 years of LSF have a significantly increased risk of dislocation and failure leading to revision hip surgery. Of the 1809 patients found to meet inclusion criteria, 7.8% sustained hip dislocation within 2 years of primary THA. This was significantly higher than the control group's rate of 4.8% without previous LSF ($P <$ .001). There was an 80% increase in dislocation risk in the fusion group in the first 6 months, 71% at 1 year, and 60% at 2 years. Sing et al [3] also demonstrated increased incidence of THA dislocation in patients with prior LSF. However, in their study, only 2% of the patients undergoing THA has a prior spine fusion, whereas in our study 4.5% of the Medicare population had an existing LSF within 5 years before their THA, highlighting the larger nature of this problem.

Spinopelvic biomechanics play a significant role in these findings. Normal spinopelvic biomechanics allow for changes in pelvic parameters based on position [6]. When standing, normal biomechanics involve pelvic anteversion or forward tilt, which increases sacral slope and decreases acetabular anteversion [6]. When seated, the pelvis normally retroverts or tilts posteriorly, causing a decreased sacral slope and increase in acetabular anteversion [6]. Acetabular anteversion, both radiographically and operatively, is changed in the face of an immobile lumbar spine [7]. With a balanced and rigid spine, the change from standing to seated position does not allow a compensatory increase in acetabular anteversion, leading to increased anterior impingement and possible dislocation in an anatomically positioned THA [7]. A fixed and rigid spine with an increased acetabular anteversion does not allow compensatory pelvic tilt adjustment and thus increases posterior hip impingement, which can promote an anterior dislocation with anatomic THA components [7]. Anatomic positioning of acetabular components in patients with spinal sagittal malalignment can lead

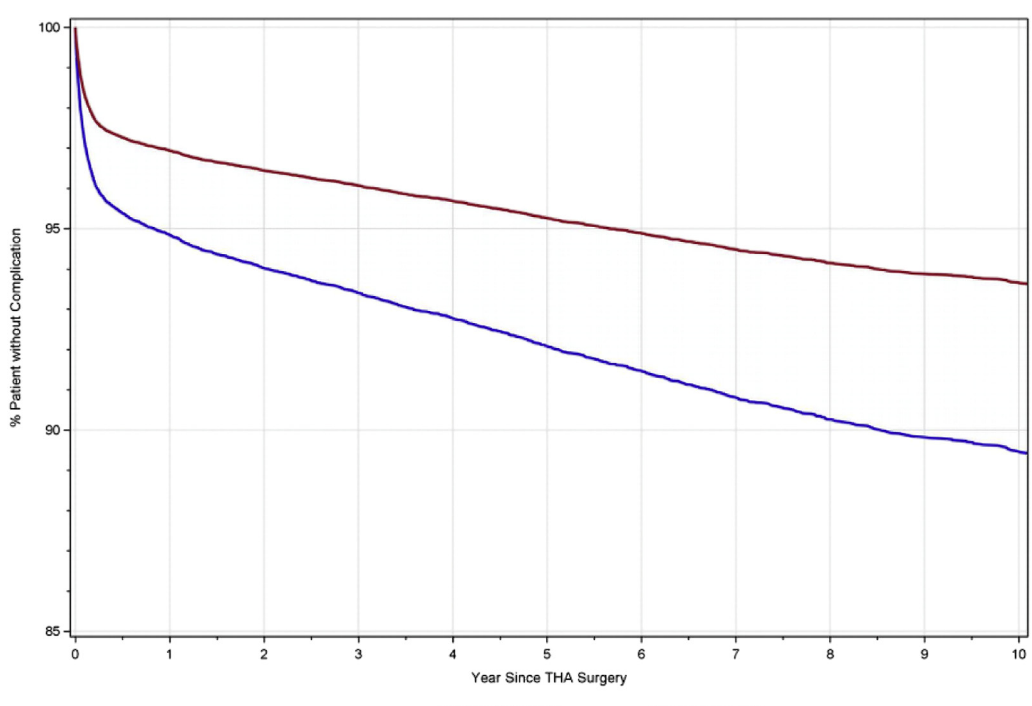

Fig. 2. Dislocation risk—all patients.

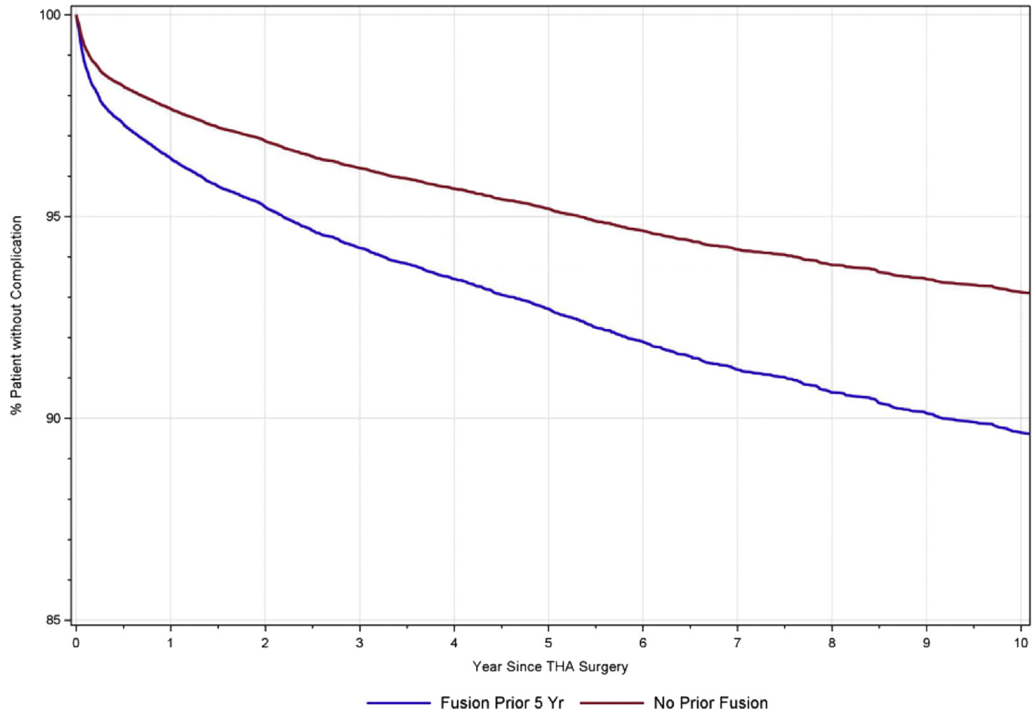

Fig. 3. Revision risk—all patients.

to instability due to impingement prompting the need to adjust the acetabular component position to compensate adequately for the spinal deformity [8]. One previous study suggests specific alterations in cup placement based on type of spinal deformity and whether the deformity is flexible or rigid [7].

The risk of failure leading to revision THA was increased by 48% at 6 months, 41% at 1 year, and 47% at 2 years in the lumbar fusion group. The type (surgical approach) of lumbar fusion was an independent risk factor for revision surgery, but not for dislocation. Dislocation was the primary mode of failure leading to revision hip arthroplasty in both the LSF group (20.8%) and the nonfusion group (16%). Sing et al [3] evaluated the risk of dislocation and revision in a study based on the extent of levels fused, short (<3 levels) vs long (>3 levels). They report similar findings as this study, suggesting that patients with previous LSF are at a significantly increased risk of dislocation following THA [3]. They also concluded that patients with long fusion segments more than 3 levels have significantly higher risk than those with shorter fusion levels [3].

Spine surgeons regularly evaluate pelvic parameters including sacral slope, pelvic tilt, and pelvic incidence during operative planning, but sagittal plane pelvic alignment is rarely evaluated or included in hip surgeons' operative plans [6]. An anteroposterior pelvis radiograph is commonly used as the basis of THA planning, whereas the lateral/sagittal imaging is commonly ignored, omitted, or unavailable [6]. In patients with a prior LSF, a more extensive preoperative plan is needed in order to properly adjust acetabular component placement in this patient group. However, at present we do not know what the ideal target functional cup positioning or “safe zone” needs to be in the lumbar fusion group given the altered spinopelvic pathoanatomy. Additional data are needed to determine whether the so-called safe zone is much tighter or has a narrower window before component impingement due to the altered dynamic pathoanatomy at the spinopelvic junction in patients with LSF. This tighter “safe zone” in LSF patients may also vary based on the level and extent of the fusion and the type of spinal balance achieved.

Given the higher risk of dislocation in patients undergoing THA with a history of prior LSF, this group may benefit from additional individualized dynamic preoperative planning to assess the level of flexibility at the spinopelvic junction during the standing and sitting positions. Greater attention during intraoperative assessment of hip stability following acetabular cup positioning is required in this high-risk group to minimize impingement given the spinopelvic pathoanatomy following LSF. As of now, no studies have looked at specific intraoperative adjustments or the use of

Table 2
Risk Factors for Revision Within 5-y of Primary THA.

Covariate	Covariate *P* Value	Level	Adjusted HR (95% Confidence Interval)	Level *P* Value
Age	.021	65-69	Reference	
		70-74	0.83 (0.73-0.95)	.005
		75-79	0.86 (0.76-0.97)	.018
		80-84	0.84 (0.73-0.95)	.007
		85+	0.77 (0.64-0.92)	.004
Charlson score	<.001	0	Reference	
		1-2	1.17 (1.06-1.30)	.002
		3-4	1.26 (1.09-1.45)	.002
		5+	1.63 (1.36-1.95)	<.001
Diabetes	.372	Yes vs no	0.95 (0.84-1.07)	.372
Prior fusion	<.001	Yes vs no	1.53 (1.24-1.90)	<.001
Medicare buy-in	.017	Yes vs no	1.20 (1.03-1.40)	.017
Obesity	.265	Yes vs no	1.07 (0.95-1.21)	.265
Race	.003	White	Reference	
		Black	0.76 (0.60-0.96)	.020
		Other	0.62 (0.40-0.96)	.034
Region	<.001	South	Reference	
		Midwest	0.82 (0.73-0.92)	<.001
		Northeast	0.81 (0.71-0.92)	.001
		West	1.00 (0.90-1.11)	.961
Sex	.056	Female vs male	1.10 (1.00-1.20)	.056
Smoking	.049	Yes vs no	1.12 (1.00-1.26)	.049
Year	.947		1.00 (0.99-1.01)	.947

THA, total hip arthroplasty; HR, hazard ratio.

Table 3
Top Reasons for Revision for Fusion and Nonfusion Patients.

Fusion Patients		Nonfusion Patients	
Description	%	Description	%
Dislocation	20.8	Dislocation	16.0
Periprosthetic fracture	20.0	Mechanical loosening	12.1
Mechanical loosening	15.2	Periprosthetic fracture	9.4
Infection	5.6	Infection	5.6

dynamic imaging to help decide on ideal cup positioning following THA in patients with LSF. Additional studies are required to determine baseline normal dynamic spinopelvic motion during standing and sitting and identify the pathoanatomy that develops following lumbar fusion.

A limitation of this study is that spine and pelvic radiographic analyses were not available with this large database study nor were the specifics as to the type of revision surgery performed due to dislocation such as component realignment or use of constrained liners. We also could not determine the direction of hip instability. Despite the limitations, we were able to determine that prior LSF is an independent risk factor for dislocation and subsequent revision in patients undergoing primary THA. These big database studies can highlight a clinical problem in a small subset of patients due to the strength or power given the large number of patients available for review. However, additional studies at institutions with access to specific patient data and radiographic analysis are required to understand the specifics of the pathoanatomy leading to increased dislocation and revision surgery in this group of patients. We also did not have access to the exact approach used in these patients. Perhaps some of the new alternative approaches would be of benefit and require additional investigation. Given the increased dislocation incidence in patients with a history of prior LSF, we would recommend the use of large femoral heads sizes and perhaps the use of dual-mobility cups along with a thorough intraoperative assessment of hip stability through a full range of motion to avoid any impingement. Given the high dislocation prevalence leading to revision in patients undergoing primary THA with prior LSF, collaborative studies between spine and arthroplasty surgeons is necessary to help identify specific changes that occur following lumbar fusion in spinopelvic anatomy in order to determine the ideal functional safe zone for acetabular cup placement.

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