OPEN Research Article

Effect of Lower Extremity Osteoarthritis on Outcomes of Lumbar Decompression

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ABSTRACT

Background: The purpose of this study is to evaluate how hip or knee osteoarthritis (OA) and total joint arthroplasty impact the outcomes of patients undergoing lumbar decompression.

Methods: A retrospective review of 342 patients undergoing lumbar decompression without fusion from January 2019 and June 2021 at a single institution was performed. Univariate and multivariate analyses were used to compare outcomes between patients with and without concomitant hip or knee OA.

Results: Forty-six percent of patients had a hip or knee OA diagnosis and were higher risk as they were older, had higher BMIs, were more likely to be former smokers, had higher ASA scores, and were more likely to undergo 3+ level surgery. Postoperatively, after adjusting for differences between groups, hip or knee OA patients were more likely to be readmitted (OR=12.45, p=0.026) or have a complication (OR=13.77, p=0.031). However, patient reported outcomes as measured by Patient Reported Outcomes Measurement Information System-physical function. were similar at 1-3 months and 3-6 months. Higher levels of physical function were observed at 3-6 months postoperatively in hip OA patients with a history of THA.

Conclusion: Patients with concomitant hip or knee OA are at higher risk for readmission and postoperative complications but may achieve similar levels of physical function as those without OA.

Osteoarthritis (OA) is the most common joint disorder affecting more than 240 million people globally.[1,2] Hip and knee OA, in this study described as lower extremity osteoarthritis (LEOA), is growing in prevalence with the aging population and is a leading cause of global disability.[3] In the United States, the prevalence of symptomatic knee OA is approximately 10 to 13% in individuals 60 years or older.[1] In Europe and North America, hip OA is frequently reported as the second most common form of OA, with an estimated prevalence of approximately 7.5 to 12.5%.[4,5] Similarly, degenerative lumbar spinal stenosis (LSS) is a common source of pain and disability, with an estimated prevalence of 11% in the general population globally.[6] Surgical treatment of LSS is often indicated, with 33%

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of diagnosed patients undergoing surgical intervention.[7] Depending on disease-specific and patient-specific factors, lumbar decompression and fusion or isolated lumbar decompression may be indicated; the incidence of both procedures has increased over 100% from 2002 to 2018.[7] In patients requiring surgical treatment for LSS, comorbid hip and knee OA has been reported with a prevalence of 2 to 35% and 5 to 41%, respectively, making these conditions important factors in the surgical planning process.[8]

The absence of normal spine-pelvis–lower extremity alignment, resulting from pathology in any part of the chain, can result in notable pain and functional impairment.[9] In the presence of disease within any element of the spinopelvic–lower extremity complex, compensatory changes can result in additional strain on other elements, leading to increased potential for the development of degenerative pathology.[10-12] To date, most studies related to the topic in surgical populations have focused on the relationship between total hip arthroplasty (THA) and lumbar fusion.[10,13-15] The effects of total knee arthroplasty (TKA) and nonsurgically managed LEOA on lumbar fusion outcomes have been evaluated with less frequency.[16-18] It is appropriate that most studies evaluating the spinopelvic–lower extremity relationship have focused on fusions, given the notable changes in sagittal alignment and spinopelvic mobility produced by the procedure.[10] However, the kinematic relationship between elements of the chain is also altered by isolated decompression procedures, which are highly effective in the treatment of LSS. Unfortunately, virtually no studies to date have evaluated the effect of LEOA and total joint arthroplasty (TJA) on the outcomes of isolated lumbar decompression surgery.

The purpose of this study was to identify the relationship between the presence of LEOA and the clinical and patient-reported outcomes of patients undergoing lumbar decompression for the treatment of degenerative spine disease. The primary goal was to evaluate whether LEOA, managed either nonsurgically or surgically, is a risk factor of complications and decreased function over the 1-year time horizon. Secondarily, we aim to assess whether patients with LEOA treated with TJA experience different outcomes than those managed with conservative therapy.

Materials and Methods

This study was deemed institutional review board exempt by the institutional clinical research committee. A retrospective chart review of all patients undergoing lumbar decompression for treatment of LSS by two board-certified surgeons at a single institution was performed. The timeline for inclusion was between January 2019 and June 2021.

Study Population

All patients included in this study underwent lumbar decompression without concomitant fusion between January 2019 and June 2021. All included patients underwent a decompressive procedure consisting of either laminectomy or laminotomy performed using either a mini-open or minimally invasive approach. Concomitant microdiskectomy and foraminotomy were performed in some cases, as required. No endoscopic decompression procedures were performed, and patients undergoing fusion were excluded. A total of 342 patients met the inclusion criteria.

Independent Variables

The electronic medical record (EMR) was abstracted to obtain patient demographics including age, body mass index (BMI), race, smoking status, worker's compensation status, chronic opioid use, American Society of Anesthesiologists (ASA) score, and the number of levels treated surgically. The presence of any hip or knee OA, unilateral hip or knee OA, or bilateral hip or knee OA was defined as a formal diagnosis of these conditions documented in the patient record before performing the decompression procedure. Kellgren-Lawrence (KL) grades of the hip and knee OA were recorded where preoperative radiographs were available. Treatments of hip or knee OA, including conservative treatment, hip injections, knee injections, THA before spine surgery, and TKA before spine surgery, were assessed.

Outcome Measures

The primary outcomes of interest were length of stay, discharge home, readmission, 1-year postoperative residual radiculopathy, 1-year postoperative revision surgery, and 1-year postoperative complication. Postoperative complications were defined as any medical or surgical complication not including residual radiculopathy. These included wound dehiscence, surgical site infection, hematoma, epidural abscess, and pulmonary embolism. Patient Reported Outcomes Measurement Information System (PROMIS) physical function (PF) scores were also recorded at the preoperative, 1- to 3-month postoperative, and 3- to 6-month postoperative periods. PROMIS-PF version 1.2 Short Form scores were completed in-person at clinic visits.

Statistical Analysis

Patients were grouped based on the presence of any hip or knee OA. Statistical analyses were used to determine differences in patient demographics between the two groups and the effect of hip or knee OA on postoperative outcomes of the decompression surgery. Multivariate linear and logistic regression was then performed to assess the relationship between hip or knee OA and postoperative outcomes after controlling for patient and surgery characteristics. Subgroup analyses of patients with hip and knee OA were then performed. Differences in postoperative outcomes were then assessed between three groups: hip OA only, knee OA only, and both hip and knee OA. Differences in postoperative outcomes were then assessed in just the patients with hip OA between those who underwent THA before spinal surgery and those who did not. Finally, differences in postoperative outcomes were then assessed in just the patients with knee OA between those who underwent TKA before spinal surgery and those who did not. Univariate analysis including chi square tests and two-sided independent sample Student t-tests were used to determine differences between the groups. The Fisher exact test was performed when the assumptions of chi square testing were not met. All statistical analyses were performed using R Studio (Version 1.4.1717© 2009-2021 RStudio, PBC). Statistical significance was assessed at $P < 0.05$.

Results

Of the 342 patients, 157 (45.9%) had hip or knee OA and 185 (54.1%) did not. Those with hip or knee OA were significantly older than those without hip or knee OA (65.26 ± 10.75 versus 51.69 ± 14.50; $P < 0.001$), had a significantly higher BMI (31.19 ± 6.31 versus 29.60 ± 6.29; $P = 0.021$), and were more likely to be a former smoker (39.5% versus 28.6%; $P = 0.046$). Patients with hip or knee OA had twice as many patients with an ASA classification of three or more (51.6% versus 25.9%; $P < 0.001$) and additionally had four times as many patients with a 3+ level surgery (12.7% versus 3.2%; $P = 0.002$) (Table 1).

Of the 157 patients who had hip or knee OA, 41(26.1%) had unilateral hip OA, 50 (31.8%) had bilateral hip OA, 54 (34.4%) had unilateral knee OA, and 61 (38.9%) had bilateral knee OA. At the time of decompression surgery, 17.2% of patients had KL grade 3 or 4 hip OA and 31.2% had KL grade 3 or 4 knee OA. Approximately 80% of patients with hip and knee OA underwent conservative treatment only, 12% had prior hip injections, and 33% had prior knee injections. A total of 28 patients (17.8%) underwent THA and 25 (15.9%) underwent TKA before lumbar decompression (Table 2).

Postoperatively, those with hip or knee OA had a longer length of stay (0.73 ± 1.79 versus 0.28 ± 0.92; $P = 0.005$), increased rate of readmission (7.0% versus 0.5%; $P = 0.042$), and increased rate of 1-year complications (4.4% versus 0.5%; $P = 0.003$). However, no notable differences were observed in rate of discharge home, 1-year residual radiculopathy, 1-year revision, follow-up time, or PROMIS score at any postoperative time point (Table 3). After adjusting for age, BMI, smoking status, ASA score, and number of surgical levels, patients with hip or knee OA were significantly more likely to experience 90-day readmissions (OR = 12.45, $P = 0.026$) and 1-year complications (OR = 13.77, $P = 0.031$) (Table 4).

Table 1. Patient Demographics

Demographics	All Patients (n = 342)	+Hip/Knee OA (n = 157)	-Hip/Knee OA (n = 185)	*P*
Age	57.92 ± 14.56	65.26 ± 10.75	51.69 ± 14.50	**<0.001**
BMI	30.33 ± 6.34	31.19 ± 6.31	29.60 ± 6.29	**0.021**
Non-White race	43 (12.6)	16 (10.2)	27 (14.6)	0.227
Current smoker	34 (9.9)	14 (8.9)	20 (10.8)	0.688
Former smoker	115 (33.6)	62 (39.5)	53 (28.6)	**0.046**
Workers compensation	8 (2.3)	2 (1.3)	6 (3.2)	0.399
Chronic opioids	132 (38.6)	58 (36.9)	74 (40.0)	0.640
ASA 3+	129 (37.7)	81 (51.6)	48 (25.9)	**<0.001**
3+ level decompression	26 (7.6)	20 (12.7)	6 (3.2)	**0.002**

ASA = American Society of Anesthesiologists, BMI = body mass index, OA = osteoarthritis
P-values < 0.05 in bold.
Data are expressed as mean ± SD or n (%).

Table 2. Hip and Knee OA Details

Hip/Knee OA Details	+Hip/Knee OA (n = 157)
Any hip/knee OA	157 (100)
Unilateral hip OA	41 (26.1)
Bilateral hip OA	50 (31.8)
Unilateral knee OA	54 (34.4)
Bilateral knee OA	61 (38.9)
Last hip KL grade before decompression[a]	
1	2 (1.3)
2	48 (30.6)
3	20 (12.7)
4	7 (4.5)
Last knee KL grade before decompression[b]	
1	6 (3.8)
2	38 (24.2)
3	39 (24.8)
4	10 (6.4)
Hip or knee OA treatment before decompression	
Conservative only	126 (80.3)
Hip injection	18 (11.5)
Knee injection	52 (33.1)
THA before decompression	28 (17.8)
TKA before decompression	25 (15.9)

OA = osteoarthritis, KL = Kellgren-Lawrence classification, THA = total hip arthroplasty, TKA = total knee arthroplasty
Data are expressed as mean ± SD or n (%).
[a]Includes patients with diagnosed hip OA only (n = 91).
[b]Includes patients with diagnosed knee OA only (n = 115).

In the subgroup analyses of patients with OA, no differences in postoperative outcomes were observed between patients with hip OA only, knee OA only, or both hip and knee OA (Table 5). In patients with hip OA, those who had a THA before lumbar decompression had a longer length of stay (0.90 ± 0.52 versus 0.25 ± 2.01; P = 0.018) and had significantly higher PROMIS-PF scores at 3 to 6 months postoperatively (48.94 ± 9.87 versus 36.34 ± 8.38; P = 0.005) than those who did not. No notable differences were observed in rate of discharge home, readmission, 1-year complication, 1-year residual radiculopathy, 1-year revision, preoperative PROMIS-PF score, PROMIS-PF score 1 to 3 months postoperatively, or follow-up time (Table 6). In patients with knee OA, no notable differences were observed in any outcome measure between those who had a history of TKA and those who did not (Table 7).

Discussion

The results of this study demonstrate that patients undergoing lumbar decompression with concomitant LEOA are at increased risk of 90-day readmissions and 1-year complications than those without LEOA. In patients with LEOA, outcomes are similar between those with hip OA, knee OA, and OA of both joints. In the population with hip OA, patients undergoing THA before lumbar decompression reported greater levels of physical function at 3 to 6 months postoperatively while similar levels of function were reported between patients with knee OA who were with and without a history of TKA. These results suggest that evaluation of hip and knee joint degeneration before performing lumbar decompression is warranted and that appropriate patients may benefit from undergoing THA before addressing the lumbar pathology.

Multiple previous studies have identified other preoperative risk factors of complications and decreased improvement in patient-reported outcome measures (PROMs) after lumbar decompression for degenerative conditions. Increased age and BMI, current smoking status, depression and anxiety, diabetes mellitus, renal failure, chronic liver disease, ischemic heart disease, arrhythmias, and autoimmune disease have all been cited as risk factors of complications and readmissions.[19-22] The relationship between preoperative comorbidities and improvements in PROMs is less well-defined. In a retrospective review of 314 patients undergoing lumbar decompression, Nolte et al[23] found that increased comorbidity burden, as measured by the Charlson Comorbidity Index (CCI), was not associated with decreased rates of achieving 1-year minimal clinically important difference (MCID) in measures of pain and disability. However, increased CCI scores were associated with lower rates of achieving MCID on measures of physical function, including the PROMIS-PF and Short Form-12 Physical Component Score (SF-12 PCS) measures. Conversely, Cha et al found that increased CCI scores were associated with lower rates of reaching MCID in pain and disability measures (the Oswestry Disability Index (ODI) and visual analog scale of back and leg pain) but not physical function measures (SF-12 and PROMIS-PF) 1 year after lumbar decompression. In addition to comorbidity burden, age, insurance status, surgical duration, blood loss, and type of spinal pathology were notable risk factors of failure to achieve MCID on various measures.[24] Beyond aggregate comorbidity burden, individual risk factors of diminished PROM improvement after lumbar decompression

Table 3. Decompression Outcomes

Outcomes	+Hip/Knee OA (n = 157)	-Hip/Knee OA (n = 185)	*P*
Length of stay (days)	0.73 ± 1.79	0.28 ± 0.92	**0.005**
Discharge home	110 (70.1)	118 (63.8)	0.266
Readmission	11 (7.0)	1 (0.5)	**0.003**
1-year complication	7 (4.4)	1 (0.5)	**0.042**
1-year residual radiculopathy	10 (6.4)	13 (7.0)	0.980
1-year revision	11 (7.0)	11 (5.9)	0.859
PROMIS-PF preoperatively	35.56 ± 7.44	35.41 ± 6.9	0.877
PROMIS-PF 1-3 Mo	39.44 ± 9.06	41.23 ± 9.37	0.323
PROMIS-PF 3-6 Mo	39.79 ± 9.18	42.17 ± 8.02	0.251
Follow-up (Mo.)	8.05 ± 7.84	6.70 ± 7.19	0.101

OA = osteoarthritis, PROMIS = Patient Reported Outcomes Measurement Information System, PF = physical function
P-values < 0.05 in bold.
Data are expressed as mean ± SD or n (%).

include increased age, heart disease, chronic kidney disease, and diabetes mellitus.[25-27] The results of this study suggest that concomitant LEOA should be added to the list of known independent risk factors of readmissions and complications after lumbar decompression. Therefore, these patients may benefit from close monitoring and additional postoperative support from resources such as nurse navigators because these services have been demonstrated to reduce complications and readmissions in spine surgery populations.[28] However, the presence of concomitant LEOA should not be considered a contraindication to surgical treatment because these patients experienced similar improvements in physical function as those without these comorbid conditions.

A notable finding from this study was that patients with LEOA who underwent THA before lumbar decompression had higher PROMIS-PF scores at 3 to 6 months postoperatively than those who did not undergo prior arthroplasty. To date, most previous studies related to the effect of prior TJA on outcomes of lumbar spine surgeries have focused on the influence of prior THA on clinical and functional outcomes after fusion rather than isolated decompression procedures. In a national database study of 44,535 lumbar fusion patients, after adjusting for age, sex, and CCI, patients with a history of THA 0 to 2 years before fusion experienced similar rates of pseudarthrosis, mechanical breakdown, revision lumbar fusion, adjacent segment disease or 30-day complications when compared with patients with no history of THA. Similar trends were observed when comparing outcomes between patients with a history of THA > 2 years before fusion and those with no history of THA, with the exception of markedly lower rates of adjacent segment disease in the prior THA group.[15] In another Swedish registry study, Enqvist et al compared 1-year PROMs after lumbar surgery between patients who had a history of THA and those who did not. The study included a mixed population of 77% decompression-alone patients and 23% decompression and fusion patients; the groups were propensity score–matched on age, sex, year of surgery, type of surgery, and preoperative PROM scores. In the multivariate analyses, a history of THA was associated with worse back pain, but no difference was observed in health-related quality of life (EQ-5D index), leg pain, or

Table 4. Multivariate Regression Effect of Lower Extremity Osteoarthritis on Postoperative Outcomes

Outcome	Odds Ratio/β	95% CI	*P*
Length of stay (β)	0.13	−0.35 to 0.61	0.605
Readmission (OR)	12.45	1.95 to 25.69	**0.026**
1-year complication (OR)	13.77	1.78 to 30.51	**0.031**

P-values < 0.05 in bold.
Controlling for age, BMI, former smoker, ASA 3+, and 3+ level surgery.

Table 5. Decompression Outcomes: Hip OA Versus Knee OA Versus Both

Outcomes	Hip OA (n = 42)	Knee OA (n = 66)	Both (n = 49)	*P*
Length of stay	0.95 ± 2.4	0.74 ± 1.91	0.51 ± 0.85	0.955
Discharge home	29 (69.0)	49 (74.2)	32 (65.3)	0.577
Readmission	4 (9.5)	4 (6.1)	3 (6.1)	0.757
1-year complication	2 (4.8)	5 (7.6)	0 (0)	0.150
1-year residual radiculopathy	1 (2.4)	4 (6.1)	5 (10.2)	0.311
1-year revision	1 (2.4)	6 (9.1)	4 (8.2)	0.383
PROMIS preoperatively	33.8 ± 8.02	35.7 ± 6.43	36.6 ± 8.25	0.086
PROMIS 1-3 Mo	37.8 ± 11.2	38.8 ± 7.71	41.0 ± 9.83	0.452
PROMIS 3-6 Mo	43.5 ± 8.04	38.2 ± 6.83	39.8 ± 11.4	0.345
Follow-up (Mo)	9.52 ± 8.80	6.74 ± 7.09	8.56 ± 7.81	0.149

OA = osteoarthritis, PROMIS = Patient Reported Outcomes Measurement Information System
P-values < 0.05 in bold.
Data are expressed as mean ± SD or n (%).

ODI scores at 1 year postoperatively.[13] The relationship between knee OA and TKA and outcomes of both decompression and fusion surgery for LSS was evaluated by Ho Lee et al. In a cohort of 141 female patients, ODI scores were compared between patients with no knee OA, knee OA without TKA, and knee OA with TKA. At 3 months postoperatively, no differences in ODI scores were observed, but by 1 year, notable differences existed, with no patients with knee OA demonstrating the lowest level of disability and patients with knee OA and without a history of TKA experiencing better outcomes than those with TKA.[18] In contrast to these studies, the results of this study demonstrate that definitive treatment of high-grade hip OA with THA before addressing lumbar pathology with decompression may actually yield improvements in postoperative physical function, while TKA did not result in poorer outcomes than nonsurgical management of knee OA. Although it is intuitive that treatment of other diseased joints would yield functional improvements, this finding is noteworthy in its deviation from previous studies showing similar or worse outcomes in patients with a history of THA or TKA. Additional investigation is warranted to confirm this finding in patients with exclusively end-stage LEOA and to evaluate the optimal timing of arthroplasty procedures before lumbar decompression.

This study does not come without limitations. As a single-institution retrospective study, our results may not

Table 6. Decompression Outcomes: Hip OA

Outcomes	Not Replaced (n = 63)	Replaced (n = 28)	*P*
Length of stay	0.25 ± 2.01	0.90 ± 0.52	**0.018**
Discharge home	46 (73.0)	15 (53.6)	0.114
Readmission	3 (4.8)	4 (14.3)	0.251
1-year complication	1 (1.6)	1 (3.6)	1
1-year residual radiculopathy	6 (9.5)	0 (0)	0.218
1-year revision	4 (6.3)	1 (3.6)	0.969
PROMIS preoperatively	34.38 ± 7.22	37.67 ± 9.45	0.197
PROMIS 1-3 Mo	39.92 ± 7.70	39.48 ± 13.25	0.926
PROMIS 3-6 Mo	36.34 ± 8.38	48.94 ± 9.87	**0.005**
Follow-up (Mo.)	9.35 ± 8.20	7.99 ± 8.55	0.482

P-values <0.05 in bold.
Data are expressed as mean ± SD or n (%).

Table 7. Decompression Outcomes: Knee OA

Outcomes	Not Replaced (n = 90)	Replaced (n = 25)	*P*
Length of stay	0.68 ± 1.67	0.72 ± 1.02	0.718
Discharge home	62 (68.9)	19 (76.0)	0.659
Readmission	3 (3.3)	2 (8.0)	0.061
1-year complication	3 (3.3)	2 (8.0)	0.647
1-year residual radiculopathy	8 (8.9)	1 (4.0)	0.701
1-year revision	10 (11.1)	0 (0)	0.179
PROMIS preoperatively	35.80 ± 6.59	37.41 ± 9.83	0.582
PROMIS 1-3 Mo	39.90 ± 8.26	39.05 ± 12.99	0.906
PROMIS 3-6 Mo	39.88 ± 10.46	37.33 ± 6.62	0.366
Follow-up (Mo.)	7.13 ± 7.41	8.90 ± 7.49	0.302

P-values < 0.05 in bold.
Data are expressed as mean ± SD or n (%).

be generalizable to the larger population of patients undergoing lumbar decompression. Second, although all patients included in this study underwent lumbar decompression for degenerative pathologies, this encompasses a range of conditions. The specific clinical and radiographic details of each case were not assessed and therefore may have influenced the results. Third, owing to the retrospective nature of this study, it is possible that patients with LEOA may have been inappropriately included in the non-LEOA group if a corresponding diagnosis was not included in the medical record. Fourth, it is possible that other unknown or uncontrolled for confounding variables influenced the results. Although our study design accounted for overall comorbidity burden and specific risk factors of suboptimal outcomes, other important patient-specific factors such as socioeconomic and psychosocial factors were not assessed. Furthermore, multiple other conditions that may affect the function of the spinopelvic–lower extremity chain, such as foot and ankle or vascular pathologies, were not evaluated. Examination of the potential influence of these factors on surgical outcomes remains an opportunity for additional investigation. Fifth, this study encompasses a relatively short follow-up of 1 year, with patient-reported outcomes captured only until 6 months postoperatively. Therefore, follow-up evaluation is warranted to evaluate the effect of LEOA on longer-term outcomes. Finally, although we assessed LEOA disease severity and prior treatments, OA is a degenerative condition encompassing a spectrum of symptoms that cannot be classified as simply present or absent. Follow-up studies are required to assess how spine surgery outcomes are affected across various presentations of LEOA. Despite these limitations, this study holds value as one of the first to examine the relationship between LEOA and outcomes of lumbar decompression procedures.

Conclusion

Patients with concomitant hip or knee OA are at higher risk of readmission and postoperative complications but can expect to achieve similar levels of physical function as those without OA after lumbar decompression. Treatment of high-grade OA with total joint arthroplasty before lumbar decompression can improve postoperative function without increasing risk of complications.

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