

SURGERY

Do Preoperative Epidural Steroid Injections Increase the Risk of Infection After Lumbar Spine Surgery?

Tyler M. Kreitz, MD, John Mangan, MD, Gregory D. Schroeder, MD, Christopher K. Kepler, MD, MBA, Mark F. Kurd, MD, Kris E. Radcliff, MD, Barrett I. Woods, MD, Jeffery A. Rihn, MD, D. Greg Anderson, MD, Alexander R. Vaccaro, MD, PhD, and Alan S. Hilibrand, MD

Study Design. Retrospective study.

Objective. To elucidate an association between preoperative lumbar epidural corticosteroid injections (ESI) and infection after lumbar spine surgery.

Summary of Background Data. ESI may provide diagnostic and therapeutic benefit; however, concern exists regarding whether preoperative ESI may increase risk of postoperative infection.

Methods. Patients who underwent lumbar decompression alone or fusion procedures for radiculopathy or stenosis between 2000 and 2017 with 90 days follow-up were identified by ICD/CPT codes. Each cohort was categorized as no preoperative ESI, less than 30 days, 30 to 90 days, and greater than 90 days before surgery. The primary outcome measure was postoperative infection requiring reoperation within 90 days of index procedure. Demographic information including age, sex, body mass index (BMI), Charlson Comorbidity Index (CCI) was determined. Comparison and regression analysis was performed to determine an association between preoperative ESI exposure, demographics/comorbidities, and postoperative infection.

Results. A total of 15,011 patients were included, 5108 underwent fusion and 9903 decompression only. The infection rate was 1.95% and 0.98%, among fusion and decompression patients, respectively. There was no association between infection and preoperative ESI exposure at any time point (1.0%, $P=0.853$), ESI within 30 days (1.37%, $P=0.367$), ESI within 30

to 90 days (0.63%, $P=0.257$), or ESI > 90 days (1.3%, $P=0.277$) before decompression surgery. There was increased risk of infection in those patients undergoing preoperative ESI before fusion compared to those without (2.68% vs. 1.69%, $P=0.025$). There was also increased risk of infection with an ESI within 30 days of surgery (5.74%, $P=0.005$) and when given > 90 days (2.9%, $P=0.022$) before surgery. Regression analysis of all patients demonstrated that fusion ($P<0.001$), BMI ($P<0.001$), and CCI ($P=0.019$) were independent predictors of postoperative infection, while age, sex, and preoperative ESI exposure were not.

Conclusion. An increased risk of infection was found in patients with preoperative ESI undergoing fusion procedures, but no increased risk with decompression only. Fusion, BMI, and CCI were predictors of postoperative infection.

Key words: infection, lumbar decompression surgery, lumbar epidural corticosteroid injection, lumbar fusion surgery, patient risk factors, postoperative complications.

Level of Evidence: 3

Spine 2021;46:E197–E202

Lumbar radiculopathy occurs in up to 5% of the adult population and can result in significant disability.¹ Lumbar epidural corticosteroid injections (ESI) provide diagnostic and therapeutic benefit in the nonoperative management of radiculopathy.^{2–6} Corticosteroids exert therapeutic effect through reduced nerve root edema, improved vascular circulation, and inhibition of pro inflammatory cytokines.^{7–9} The number of lumbar epidural steroid injections performed has increased substantially in recent time, with more than 2 million performed annually among Medicare patients.^{10,11} Some patients who receive lumbar ESIs may ultimately require surgical intervention. Due to modulation of immune and inflammatory pathways, there is concern regarding postoperative infection in those patients receiving preoperative ESI.

Recently, several studies have evaluated the association between preoperative ESI and postoperative infection in

From the Department of Orthopaedic Surgery, Rothman Orthopaedic Institute, Thomas Jefferson University Hospital, Philadelphia, PA

Acknowledgment date: April 30, 2020. First revision date: July 13, 2020. Acceptance date: August 10, 2020.

The manuscript submitted does not contain information about medical device(s)/drug(s).

No funds were received in support of this work.

Relevant financial activities outside the submitted work: board membership, consultancy, grants, stocks, royalties.

Address correspondence and reprint requests to Tyler M. Kreitz, MD, Department of Orthopaedic Surgery, Rothman Orthopaedic Institute, Thomas Jefferson University Hospital, Philadelphia, PA 19107; E-mail: tyler.m.kreitz@gmail.com

DOI: 10.1097/BRS.0000000000003759

patients undergoing lumbar surgery. Two retrospective single-institution studies have demonstrated no association between preoperative ESI and postoperative infection in patients undergoing lumbar decompression only,^{12,13} while another demonstrated increased rate of surgical site infection in patients undergoing lumbar fusion.¹⁴ Two large retrospective database studies have demonstrated increased risk of surgical site infection in Medicare patients undergoing lumbar decompression¹⁵ and those undergoing lumbar fusion¹⁶ receiving ESI within 3 months of surgery. The purpose of this study was to evaluate the association and possible temporal relationship between preoperative ESI, patient demographics, and comorbidities on postoperative infection in a large population of patients undergoing lumbar fusion and those undergoing decompression procedures at a single institution.

MATERIALS AND METHODS

Institutional Review Board approval was obtained for this retrospective study. All elective lumbar spine procedures performed for a diagnosis of lumbar radiculopathy and/or spinal stenosis conducted at a single institution by all surgeons between 2000 and 2017 were identified by CPT code (63030, 63047, 22612). Only those patients undergoing elective lumbar surgery for radiculopathy or spinal stenosis with minimum 90 days follow-up were included. Those patients who underwent lumbar procedures for trauma, infection, tumor, and revision procedures were excluded. Those who also underwent preoperative lumbar epidural corticosteroid injection (ESI) were also identified by CPT code (62311, 64475, 64483, 64493). Patients were categorized as having no preoperative ESI, preoperative ESI less than 30 days, 30 to 90 days, and greater than 90 days prior to lumbar surgery. All surgical procedures were performed by orthopedic spine surgeons at a single private academic practice. Included surgeons perform spine procedures at a tertiary facility, community, and orthopedic specialty hospitals. All epidural injections were performed by physiatrists within the same institution.

The primary outcome measure was postoperative surgical site infection requiring reoperation within 90 days of surgery. Patients with a diagnosis of surgical site infection were identified by ICD code (996.67, 998.12, 998.31,

998.32, 998.59, T81.31XA, T81.32XA, T84.7XXA). All patients identified as postoperative infections using ICD codes were also verified by individual chart review. Only those infections occurring within 90 days of index lumbar procedure were included.

In addition to preoperative ESI exposure, demographic information including sex, age, body mass index (BMI), Charlson Comorbidity Index¹⁷ (CCI), and presence of lumbar fusion were identified. Univariate regression analysis was performed to determine an association between background variables (preoperative ESI exposure, age, sex, BMI, CCI, and presence of lumbar fusion) and postoperative infection as the dependent variable. Categorical data were analyzed with the Chi Square Test and continuous data with the two-tailed Student *t* test. Statistical significance was set with at 0.05. Data analysis was performed using SPSS software (Version 22.0, IBM, Armonk, NY).

RESULTS

A total of 15,011 patients underwent elective lumbar spine surgery for radiculopathy and/or spinal stenosis between 2000 and 2017 and were included.

Of these, 5108 underwent fusion procedures and 9903 underwent decompression only. A total of 97 (0.98%) decompression patients were diagnosed with postoperative infection. 2957 of the decompression patients had preoperative ESI, 508 within 30 days of surgery, 1252 within 30 to 90 days of surgery, and 1197 greater than 90 days before surgery. There was no increased rate of infection among the decompression patients who had preoperative ESI compared to those without (1.0% *vs.* 0.96%, $P=0.853$). Among the temporal subgroups, there was also no increased rate of postoperative infection in those patients who had ESI within 30 days of surgery (1.37% *vs.* 0.96%, $P=0.367$), when compared with those undergoing ESI 30 to 90 days before surgery (0.63%, $P=0.257$) nor those who underwent ESI more than 90 days prior to surgery (1.3%, $P=0.277$) (Table 1).

A total of 5108 patients underwent lumbar fusion procedures, 1383 of whom had preoperative ESI. One hundred (1.95%) of the 5108 fusion patients were diagnosed with postoperative infection. Of the fusion patients, 87 had lumbar ESI within 30 days of surgery, 457 within 30 to

TABLE 1. Lumbar Decompression Surgery and Infections

Decompression Cohort	Total Patients	Infections
All patients	9903	97 (0.98%)
No ESI	6946	67 (0.96%)
Preop ESI	2957	30 (1.0%, $P=0.853$)
ESI < 30 days	508	7 (1.37%, $P=0.367$)
ESI 30–90 days	1252	8 (0.63%, $P=0.257$)
ESI > 90 days	1197	15 (1.3%, $P=0.277$)

Total number of patients who underwent lumbar decompression surgery organized by those who received preoperative ESI with temporal subgroups (within 30 days, 30–90 days, and > 90 days preoperatively) and those with no preoperative ESI. Also shows the number of postoperative infections within each subgroup. Infection rate was compared versus those patients without preoperative ESI.

Significance was set at 0.05.

TABLE 2. Lumbar Fusion Surgery and Infections

Fusion Cohort	Total Patients	Infections
All patients	5108	100 (1.95%)
No ESI	3725	63 (1.69%)
Preop ESI	1383	37 (2.68%, <i>P</i> = 0.025*)
ESI < 30 days	87	5 (5.74%, <i>P</i> = 0.005*)
ESI 30–90 days	457	7 (1.53%, <i>P</i> = 0.78)
ESI > 90 days	839	25 (2.9%, <i>P</i> = 0.022*)

Total number of patients who underwent lumbar fusion surgery organized by those who received preoperative ESI with temporal subgroups (within 30 days, 30–90 days, and > 90 days preoperatively) and those with no preoperative ESI. Also shows the number of postoperative infections within each subgroup. Infection rate was compared versus those patients without preoperative ESI.

*Significance was set at 0.05.

90 days of surgery, and 839 greater than 90 days before surgery. There was a significantly higher rate of infection among the fusion patients who had a preoperative ESI compared to those without (2.68% *vs.* 1.69%, *P* = 0.025). Among the temporal subgroups, there was a significantly higher rate of postoperative infection among those patients who underwent ESI within 30 days of surgery (5.74%, *P* = 0.005) and those undergoing ESI greater than 90 days before surgery (2.9%, *P* = 0.022) compared to those fusion patients without preoperative ESI. There was no increased risk of postoperative infection in those fusion patients who underwent ESI within 30 to 90 days of surgery (1.53%, *P* = 0.78) (Table 2).

All patients had available sex, age, and fusion data. A total of 10,978 and 7036 patients had available BMI and CCI data respectively. Regression analysis of available data demonstrated that lumbar fusion (*P* < 0.001), BMI (*P* < 0.001), and CCI (*P* = 0.035) were independent predictors of postoperative infection. Age (*P* = 0.612), sex (*P* = 0.383), and exposure to preoperative ESI at any time point (*P* = 0.091) were not significantly predictive of postoperative infection (Table 3).

DISCUSSION

This large retrospective single-institution study of over 15,000 patients demonstrates increased risk of infection

among those patients undergoing lumbar fusion who received ESI within 30 days of surgery. There was no temporal relationship between preoperative lumbar ESI and postoperative infection in those patients undergoing lumbar decompression only. Among all patients undergoing lumbar surgery; fusion procedures, body mass index, and Charlson Comorbidity Index were independent predictors of postoperative infection. Exposure to preoperative ESI had a marginal but insignificant impact on postoperative infection among all patients undergoing lumbar surgery. One prospective multiinstitutional study and two retrospective single-institution studies have demonstrated no association between preoperative ESI and postoperative infection in patients undergoing lumbar surgery¹⁸ and lumbar decompression procedures only;^{12,13} while another demonstrated increased rate of surgical site infection in patients undergoing lumbar fusion procedures.¹⁴ Two large retrospective PearlDiver database studies have demonstrated increased risk of surgical site infections in Medicare patients undergoing lumbar decompression¹⁵ and those undergoing lumbar fusion¹⁶ receiving ESI within 3 months of surgery. However, the effect of preoperative ESI on postoperative infection after decompression alone is unclear.^{12–16}

We demonstrated an increased risk of infection in patients receiving ESI within 30 days of lumbar fusion procedures. This increased risk of infection was not demonstrated in those patients receiving preoperative ESI between 30 and 90 days prior to surgery, suggesting that the increased risk of infection and immunomodulatory effect of preoperative ESI may only be temporary. Additionally, among all patients undergoing lumbar surgery, fusion was an independent predictor of postoperative infection. These findings are consistent with recent publications. One retrospective study by Zusman *et al*¹⁴ evaluated differences in postoperative complications after thoracolumbar fusion in patients receiving preoperative ESI compared to those without preoperative ESI. Of the 280 patients, 117 patients received preoperative ESI at any time point. Those receiving preoperative ESI demonstrated an 8-fold increased rate of postoperative wound complications requiring return to the operating room (5.1%) compared to those without preoperative ESI (0.6%, *P* = 0.02), consistent with our findings. The authors hypothesized that preoperative ESI may result

TABLE 3. Regression Analysis and Demographic Variables

Demographic Variable	Significance
Age	<i>P</i> = 0.612 OR 0.996 (0.982–1.011)
Sex	<i>P</i> = 0.383 OR 0.846 (0.580–1.233)
ESI exposure	<i>P</i> = 0.091 OR 1.397 (0.948–2.060)
Fusion	<i>P</i> < 0.001* OR 2.019 (1.524–2.675)
BMI	<i>P</i> < 0.001* OR 1.081 (1.055–1.108)
CCI	<i>P</i> = 0.019* OR 1.190 (1.012–1.398)

Results of regression analysis on the effect of demographic variables (age, sex, ESI exposure at any time point, fusion procedure, BMI, and CCI) on postoperative infection in all patients undergoing lumbar spine surgery. Odds ratio (OR) with 95% confidence interval.

*Significance was set at 0.05.

in altered microenvironment predisposing to postoperative infection in those patients receiving ESI. This study is limited by its relatively small number of patients.

Another study by Singla *et al*¹⁶ identified 88,540 Medicare patients undergoing one or two-level lumbar fusion between 2005 and 2012 using the PearlDiver database. They demonstrated significantly increased infection risk among 1699 patients undergoing fusion surgery within 30 days of ESI (3.9%, $P < 0.0001$) and 5491 undergoing surgery within 30 to 90 days of ESI (2.2%, $P = 0.0002$) compared to matched cohort that did not receive preoperative ESI. They concluded that preoperative ESI increased infection risk in patients undergoing fusion procedures and that the immunosuppressive effect of corticosteroids may dissipate overtime. The PearlDiver database is limited to Medicare patients; therefore, results may not be applicable to the general population. Additionally, there is concern regarding use of large nationwide databases including reliance on coding, incorrect coding, and missing data.^{19–21} Previous analysis has suggested a Medicare billing and payment error rate of 3.9% to 10%.^{22,23} With these limitations in mind, this large PearlDiver database study supports our findings of increased risk of infection in patients undergoing lumbar fusion who received preoperative ESI.

We demonstrated no temporal relationship between preoperative ESI and postoperative infection rates among patients undergoing lumbar decompression procedures only. Hartveldt *et al*¹² identified 5311 patients who underwent lumbar surgery for degenerative pathology between two institutions, 945 (18%) of whom had at least one ESI within 90 days of surgery. They demonstrated no association between postoperative surgical site infection requiring operative intervention and ESI within 30 days of index procedure ($P = 0.376$) or within 90 days of index procedure ($P = 0.296$). They did however demonstrate a significant association between hospital length of stay, estimated blood loss (EBL), posterior lumbar approach, and drain use. This study did not evaluate patient-specific differences in those undergoing procedures. Another retrospective study by Seavey *et al*¹³ identified 6535 patients undergoing single-level laminectomy between 2009 and 2014 in the Military Health System Data Repository, 847 (12.9%) of whom received preoperative ESI. There was no difference in 90-day postoperative SSI and ESI within 30 days ($P = 1$), 90 days ($P = 0.28$), 180 days ($P = 0.21$), or 365 days ($P = 0.5$) of lumbar decompression. Despite both retrospective studies evaluating relatively large cohorts, they may still be underpowered to demonstrate effect for each cohort of patients. Additionally, the study by Seavey *et al*¹³ may lack applicability of military patients to the general population. Nevertheless, there was no association between preoperative ESI at any time point and patients undergoing lumbar surgery in either study.

A recent study by Farshad *et al*¹⁸ demonstrated no association between preoperative ESI and risk of revision surgery for surgical site infection in patients undergoing lumbar surgery in the Swiss Lumbar Stenosis Outcome

Study cohort. This multicenter cohort study matched 10 of 422 (2.4%) patients who had revision surgery for surgical site infection or wound-healing problems to 19 control patients by demographics and comorbidities. They demonstrated no increased risk of preoperative ESI exposure at any time point. This study is limited by the number of patients and underpowered to demonstrate effect of preoperative ESI on postoperative infection. There was also no stratification of patients by those receiving fusion or decompression only.

On the other hand, Yang *et al*¹⁵ identified over 36,000 patients who underwent single-level lumbar decompression between using the PearlDiver database between 2005 and 2012. They demonstrated significantly greater postoperative surgical site infection rate in 2261 patients undergoing surgery within 30 days of ESI (1.7%, $P < 0.0001$) and 5697 patients undergoing surgery within 30 to 90 days of ESI (1.2%, $P < 0.0001$). There was no increased infection rate in those identified patients receiving ESI greater than 90 days before lumbar decompression. This study is also limited by its reliance on a database and inclusion of only Medicare patients whose age and other comorbidities may confound their findings and limit applicability to the general population.

Our study demonstrates that those patients undergoing preoperative ESI within 30 days of lumbar fusion were at increased risk of postoperative infection. This was not true of those patients who received ESI 30 to 90 days prior to lumbar fusion suggesting a possible temporary increase risk and immunomodulatory effect of ESI on increased infection risk. Those patients who received ESI greater than 90 days prior to lumbar fusion also had significantly increased rates of postoperative infection compared to those without ESI exposure. It is possible that those patients who received ESI greater than 90 days prior to surgery may have had increased comorbidities or other contributing factors that may have delayed any surgical intervention, and confounding postoperative infection risk. Additionally, this group includes patients who had received ESI at our institution 3 months prior to and potentially over several years prior to lumbar fusion. This variability in patient population may further confound infection risk in this subset of patients. Comparatively, we did not demonstrate increased risk of postoperative infection in those decompression patients who received preoperative ESI at any time point. Presence of lumbar fusion was an independent predictor of postoperative infection among patients undergoing lumbar surgery, while ESI exposure was not. Those patients undergoing fusion may be at higher risk of postoperative infection due to greater operative time, increased soft tissue exposure, increased blood loss, and surgical instrumentation required for fusion may predispose to postoperative infection.^{24–28}

Patient-specific factors and comorbidities should also be considered when evaluating postoperative infection risk in patients indicated for lumbar surgery. In this study, patient-specific factors and comorbidities (Charlson Comorbidity Index and BMI) were independent predictors of

postoperative infection, while exposure to preoperative ESI at any time point was a marginal but insignificant predictor of postoperative infection. Consistent with our findings, previous studies have identified increased BMI, age, hypoalbuminemia, and medical comorbidities including CAD, DM, COPD, liver disease, autoimmune disease^{25–33} as predictors of postoperative infection after lumbar surgery. Additionally, surgery-specific variables such as blood loss, operative time, approach, and number of operative levels have been associated with risk of postoperative infection.^{26,29,34,35} Reported rates of infection after lumbar surgery range from 0.7% to 3.9%.^{25–33} We reported an overall infection rate, 1.3%, on the lower end of this range. Reflecting our strict definition of infection as only those patients requiring return to the operating room within 90 days if index procedure. The results of this study suggest that patient's BMI and comorbidities should be considered when evaluating risk of postoperative infection in patients indicated for lumbar surgery, especially lumbar fusion procedures.

This study is limited by its retrospective design and identification of patients based on CPT and ICD codes. Only patients who received ESI at our institution were identified, and our study design did not identify patients receiving ESI at outside institutions. Further, demographic information, specifically BMI and CCI, was not available for all patients, limiting the sub analysis of these variables. Smoking status was initially considered as an additional variable, but excluded due to limited patient smoking data. Additionally, all patients undergoing lumbar surgery were included regardless of surgical complexity, number of operative levels, and presence of combined anterior, lateral, and posterior approaches. Nevertheless, this is the largest single-institution study evaluating the effect of preoperative ESI on postoperative infection after lumbar surgery, and the only study to examine separately those undergoing fusion and decompression only.

This large retrospective single-institution study of over 15,000 patients undergoing lumbar spine surgery demonstrates increased risk of infection among those patients undergoing lumbar fusion who received ESI within 30 days of surgery. There was no association between preoperative lumbar ESI and postoperative infection in those patients undergoing lumbar decompression only. Among all patients undergoing lumbar surgery fusion procedures, body mass index, and Charlson Comorbidity Index were independent predictors of postoperative infection. Exposure to preoperative ESI had a marginal but insignificant impact on postoperative infection among all patients undergoing lumbar surgery. These factors should be measured when considering infection risk in those patients indicating patients for lumbar surgery, especially fusion procedures. Given our data, avoiding or postponing fusion procedures in patients who have had ESI within 30 days should be considered when possible, especially in those patients with additional risk factors for infection. Further studies are needed to elucidate the

relationship between preoperative ESI and surgical site infection risk in lumbar fusion patients.

➤ Key Points

- ❑ Patients undergoing lumbar fusion surgery had an increased risk of infection with preoperative ESI.
- ❑ However, there was no increased risk of infection for patients undergoing lumbar decompression with preoperative ESI.
- ❑ Fusion, BMI, and CCI were independent predictors for increased risk of postoperative infection.

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