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Comparison of Lumbar Epidurals and Lumbar Plexus Nerve Blocks for Analgesia Following Primary Total Hip Arthroplasty: A Retrospective Analysis

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Abstract

Background: Total hip arthroplasty (THA) is associated with significant postoperative pain. Both lumbar epidurals and lumbar plexus nerve blocks have been described for postoperative pain control, but it is unclear if one technique is more beneficial.

Methods: Using electronic medical records, a randomly selected, cohort of 58 patients with lumbar epidurals were compared with 58 patients with lumbar plexus nerve blocks following primary THA. The primary end point was 48-hour postoperative opiate consumption. Secondary end points included time of first ambulation, distance ambulated, level of assistance with ambulation, presence of side effects, and time to discharge. Descriptive statistics were calculated to characterize subjects in the different block-type groups. Comparisons in morphine consumption were conducted using linear mixed models. Primary and secondary end points were examined in multivariable models.

Results: Patients with lumbar plexus blocks consumed less opiates at 24, 36, and 48 hours relative to patients that received lumbar epidural catheters ($P = .047$, $.002$, and $.002$, respectively). Patients with lumbar plexus blocks ambulated earlier (24.6 ± 2.01 hours vs 31.7 ± 3.01 hours) and farther relative to patients with epidurals ($P < .001$ for both) and had discharge orders written earlier (58.2 ± 6.68 hours vs 73.6 ± 6.35 hours).

Conclusion: In comparison to lumbar epidural catheters, lumbar plexus nerve blocks are an effective pathway for postoperative pain control following primary THA. Furthermore, this

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clinical pathway expedites physical rehabilitation and is more compatible with postoperative prophylactic anticoagulants.

Total hip arthroplasty (THA) is a very successful surgery with a growing patient population [1], but it is often associated with significant postoperative pain that can impede rehabilitation [2]. Hip pain is what often prompts patients to seek out THA, so recurrent or persistent pain after surgery is a serious concern [3]. Inadequately treated pain in the immediate postoperative period can decrease postoperative ambulation and consequently increase pulmonary issues and venous thromboembolism [4,5].

The perioperative care of patients undergoing THA lends itself to a variety of regional techniques for postoperative analgesia. Multiple randomized control trials and a systematic review have described decreased pain scores and opioid consumption when comparing postoperative regional analgesia to systemic analgesia [6–9]. However, regional techniques are seldom compared. Continuous epidural analgesia (CEA) has been proven to be a superior technique to intravenous (IV) analgesia alone for analgesia after THA [10]. However, CEA does have some well-known side effects such as urinary retention, systemic hypotension, and leg weakness that may impede immediate postoperative patient rehabilitation. In addition, patients are at increased risk of venous thromboembolism (VTE) formation following THA and are often started postoperatively on anticoagulants that are not compatible with an indwelling epidural catheter [11]. In contrast, lumbar plexus blocks have been shown to reduce postoperative pain with avoidance of some of the previously mentioned side effects of neuraxial analgesia [9,12,13]. In addition, the sciatic nerve is not anesthetized with a lumbar plexus block, allowing for assessment of sciatic nerve palsy; a rare but devastating complication after THA.

The present study examined a retrospective cohort of patients undergoing primary THA that received a single-injection lumbar plexus nerve block or continuous lumbar epidural catheter with oral and IV opioids. We hypothesized that lumbar plexus nerve blocks would provide adequate postoperative analgesia. Our primary outcome was cumulative opioid consumption 48 hours after surgery measured in IV morphine equivalents. Secondary outcomes included time of first ambulation, distance ambulated, level of assistance needed to ambulate, presence of opioid side effects, time to discharge, and urinary catheter requirement.

Materials and Methods

After institutional review board approval, a retrospective cohort study was conducted utilizing electronic medical records to examine patients who underwent primary THA by the direct lateral approach at a single academic institution between January 2010 and June 2013 ($n = 766$). Written informed consent was waived by the institutional review board. The trial was registered at [clinicaltrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT02186795) (NCT02186795; 07/08/2014).

Power

Based on a study conducted by Milligan et al [14], 24-hour IV morphine equivalent consumption in the epidural group was expected to be $35 \text{ mg} \pm 20 \text{ mg}$. Assuming 35 mg IV morphine equivalent consumption in the epidural group, a sample size of 58 subjects per

group was needed to provide 80% power to detect a 30% change from 35 mg in IV morphine equivalent consumption between the epidural and lumbar plexus patients for a 2-sided test at a significance level of $\alpha = 0.05$. Calculations were based on a *t* test hypothesis-testing framework. Since the analysis involved repeated observations of each subject, power was likely underestimated.

Study Design

Current Procedure Terminology code 27,130 was used to identify potential patients between January 2010 and June 2013. Electronic medical records were then reviewed to identify which patients met inclusion/exclusion criteria. Patient selection is shown in Figure 1. Inclusion criteria consisted of primary, elective THA surgery with either (1) a lumbar epidural ($n = 547$) or (2) a lumbar plexus peripheral nerve block ($n = 219$) for postoperative analgesia. Exclusion criteria included THA revision, traumatic fractures, nonelective surgeries, and postoperative intensive care unit admission. Of the charts reviewed, 342 epidural and 107 lumbar plexus patients met inclusion criteria. Subjects meeting inclusion criteria were assigned a chronological number based on the date of their operation (Epidural 1–342; Lumbar plexus 1–107) and then randomized using Microsoft Excel. Data were collected on the first 58 randomized subjects in each group; 58 epidural patients and 58 lumbar plexus patients.

Data Collection

To ensure accurate data collection, patient charts were reviewed and data collected by 2 separate investigators. A third investigator reviewed all data collection.

The primary outcome was cumulative opioid consumption 48 hours after surgery. All opioids were converted to IV morphine equivalents for ease of comparison. In reference to 1-mg IV morphine, conversion factors were fentanyl IV (0.01 mg), hydromorphone IV (0.15 mg), meperidine IV (7.5 mg), oral oxycodone (2 mg), and oral hydrocodone (3 mg). Opioid consumption was recorded in 12-hour intervals (0–12, 12–24, 24–36, 26–48 hours) until 48 hours postoperatively or discharge, whichever occurred first. The documented “anesthesia end” time was used as time zero. To include all opioids on the day of surgery, all medications administered in preoperative holding, the operating room or post-anesthesia care unit (PACU) were included in the opioid consumption for the first 12 hours postoperative time interval.

Multiple secondary outcomes were evaluated. Variables included demographic data, administration of nonopioid pain medications (gabapentin, pregabalin, celecoxib, and acetaminophen) preoperatively or postoperatively, total operating room time, and anesthetic type (general or spinal). Postoperative secondary end points included time of first ambulation, distance ambulated, and level of assistance needed to ambulate. Level of assistance needed to ambulate was assigned a number based on the Functional Independence Measure scale (1 = Total assistance: subject contributes <25% of the effort or is unable to do task. 2 = Maximal assistance: subject contributes <50% of effort. 3 = Moderate assistance: subject contributes 50%–75% effort. 4 = Minimal assistance: incidental hands-on help only and subject performs >75% effort. 5 = Supervision: only standby assistance with verbal

prompting or help with setup. 6 = Modified independence: subject may use assistive device but without physical help. 7 = Complete independence) [15]. Other postoperative secondary outcomes included discharge time, urinary catheter requirements, and common side effects including nausea (administration of ondansetron or promethazine), pruritus (administration of diphenhydramine or hydroxyzine), dizziness (documented by physical therapy or nursing), or hypotension (documented by blood pressure greater than 20% below baseline).

Statistics

Our primary comparison of interest was total opioid consumption over time by the type of regional technique used for postoperative pain. Descriptive statistics were calculated to characterize subjects in the different block-type groups. Comparisons in morphine consumption were conducted using linear mixed models including a random subject effect to account for repeated measures of opioid consumption over time. In a multivariable model, main effects for type of block and time as well as an interaction between block type and time were considered. We explored different covariance structures including first-order autoregressive, heterogeneous first-order autoregressive, compound symmetry, and unstructured, selecting the most appropriate structure by comparing Akaike information criterion. Model assumptions were checked graphically, and variable transformations were considered when appropriate. Contrasts were used to examine differences between block types at each time point. The Tukey-Kramer adjustment was used to control for multiple comparisons.

Secondary outcomes included time to first ambulation, distance ambulated, level of assistance required with ambulation, time to discharge orders, and occurrence of side effects. Similar to cumulative opioid consumption, linear mixed models were also used to examine associations between different variables and the secondary outcome distance ambulated. Generalized linear mixed models with a cumulative logit link were used to examine the association between different variables and level of assistance required to ambulate to account for repeated measures over time. Associations between categorical variables and the continuous outcomes time to first ambulation and time to discharge orders were evaluated using independent *t* test or Wilcoxon Mann-Whitney U test where appropriate, and associations with continuous variables were evaluated using Pearson's correlation or Spearman's rank correlation where appropriate. Associations between categorical variables and occurrence of side effects (any time during postoperative day [POD] 0–2) were evaluated using chi-square tests and with logistic regression for continuous variables. All analyses were done using SAS v 9.3 (SAS Institute, Cary, NC).

Results

Data were successfully collected on 58 patients in each group. The data set was nearly complete. There were zero missing data points for the multivariable model of the primary outcome of opioid consumption. For all secondary outcomes, less than 3% of the data points were missing.

All regional blocks were placed preoperatively on the day of surgery in the preoperative holding area. All blocks were placed for the purpose of postoperative analgesia. Lumbar

epidurals were bolused intraoperatively before an infusion of ropivacaine (0.2%) was started at 8 mL/h. Epidural rates were titrated in the PACU for patient comfort before discharge to the floor. All epidurals were removed the morning of POD 1 to allow for the administration of anticoagulants for VTE prevention. Lumbar plexus blocks were performed as a single injection with 20 mL of 0.5% ropivacaine.

Demographic data for the cohort are presented in Table 1. Patients in both groups were similar in terms of age, gender, race, total operating room time, and intraoperative anesthesia type. All urinary catheters were placed intraoperatively, and placement was associated with a lumbar epidural ($P < .001$). Patients with a lumbar plexus block were more likely to perioperative celecoxib ($P < .001$) or gabapentanoids (pregabalin or gabapentin) ($P < .001$) but acetaminophen utilization did not differ ($P = .364$; Table 2).

Primary Outcome

Cumulative opioid consumption differed by block type at 48 hours postoperatively ($P = .002$, Table 1). Cumulative opioid consumption also differed by block type at 24 and 36 hours postoperatively ($P = .047$ and $.002$, respectively) but not at 12 hours (Table 1).

In a multivariable model, cumulative opioid consumption was increased with epidural analgesia (vs lumbar plexus block), increased postoperative time (eg, 48 vs 36 hours), epidural analgesia with increased postoperative time combined (block type by time interaction), decreased age, and general anesthesia (Table 3). After controlling for anesthesia type and age, patients with a lumbar plexus block continued to consume significantly less opioids at 24, 36, and 48 hours relative to patients that received an epidural block ($P = .034$, $.001$, and $.002$, respectively, Fig. 2).

Secondary Outcomes

Patients with lumbar plexus blocks ambulated earlier relative to patients with epidurals (mean $\pm$ standard error; 24.6 ± 2.01 hours vs 31.7 ± 1.54 hours; $P < .001$).

Distance ambulated was increased in patients that received a lumbar plexus block (vs epidural, $P < .001$). Univariate analysis also showed distance ambulated to be increased with male gender, shorter time to first ambulation, decreased total opioid consumption, and increased time. In a multivariable model, distance ambulated was increased with lumbar plexus block, later POD, and male gender (Table 4). Patients who received lumbar plexus blocks ambulated further on POD 0, 1, and 2 than patients who received an epidural while controlling for other factors. Specifically, patients who received a lumbar plexus block ambulated 25.8 ± 7.8 feet (mean $\pm$ standard error) further than patients who received an epidural on POD 0 ($P = .001$), 83.1 ± 13.6 feet further on POD 1 ($P < .001$), and 73.1 ± 17.1 feet further on POD 2 ($P < .001$; Fig. 3). All patients were on fall precautions postoperatively, and no falls were recorded.

Level of assistance for ambulation was also examined in univariate and multivariable models using the Functional Independence Measure scale [15]. Odds ratios are presented for the multivariable model in Table 5. Patients who received an epidural block had 2.5 times the odds of needing more assistance relative to patients who received a lumbar plexus block

controlling for other factors ($P = .009$). The odds of needing greater assistance to ambulate were also increased in patients with earlier POD, African-American race, female gender, increased age, and later time to first ambulation.

Patients with the lumbar plexus blocks had discharge orders written earlier (58.4 ± 3.46 vs 73.6 ± 3.24 , $P < .001$). They also experienced less nausea ($P = .022$), pruritus ($P = .04$), dizziness ($P = .004$), and hypotension ($P < .001$).

Discussion

In this retrospective study in patients undergoing primary, elective THA, cumulative opioid consumption was compared in patients receiving single-injection lumbar plexus blocks or lumbar epidural infusions. Opioid consumption was significantly decreased in patients with lumbar plexus blocks 12–48 hours postoperatively. Furthermore, these findings persisted in a multivariable model. The most likely reason that opiate consumption did not differ between groups from 0- to 12-hour period postoperatively is that all pre-operative, intraoperative, and PACU opiate consumption was grouped into this period. This also likely explains why our opioid consumption overall was greater than expected. However, this also accounts for variation in opioid administration before PACU. Our data indicate that lumbar plexus are as effective for postoperative pain management as lumbar epidural analgesia after THA.

Our findings are notably contrasted by a small prospective study by Duarte et al [16] comparing CEA to continuous lumbar plexus blocks following THA. In this study, epidural patients had lower 48-hour opioid consumption; however, epidural patients also received neuraxial opioids (fentanyl 3 $\mu\text{g/mL}$) in their postoperative infusion. Our study differs from Duarte et al in that our epidurals were removed the morning of POD 1 to allow for pharmacologic VTE prophylaxis, and lumbar plexus blocks were single preoperative injections. In addition, our 48-hour opioid consumption captures patients participating in physical therapy which was not started until 48 postoperatively in the Duarte et al study.

Since early postoperative physical therapy has been demonstrated as one of the most important factors for continued rehabilitative success after THA [4,5], several secondary end points related to functional recovery were examined including time to first ambulation, distance ambulated, and level of assistance required with ambulation. These outcomes were improved in patients receiving lumbar plexus nerve blocks compared to the continuous epidural infusions. Delayed ambulation in patients with epidural analgesia may have been due to the increased systemic side effect (nausea and pruritus) caused by increased opioid consumption or sympatholytic side effects (hypotension and dizziness). In addition, the increased level of required assistance may be a marker of increased lower extremity weakness from lumbar epidural analgesia.

Other past studies have also shown lumbar plexus block to promote therapy after THA. A prospective, randomized study of 225 patients undergoing THA found that patients with lumbar plexus blocks ambulated farther than patients with either continuous femoral blocks or IV patient controlled analgesia alone [13]. Interestingly, other comparisons of epidural analgesia to systemic analgesia have not found a difference in rehabilitative outcomes [9,17].

Conversely, Duarte et al [16] did not find continuous lumbar plexus blocks to improve rehabilitation compared with continuous epidurals analgesia. However, this small study utilized continuous infusions for a prolonged period for both block types and did not start physical therapy until 48 hours postoperatively with a mean time to first ambulation of 3.3 days. Our results show a marked difference in postoperative physical function when comparing CEA to lumbar plexus blocks. Other studies have shown lumbar plexus blockade for postoperative analgesia to promote ambulation after THA [13] and decrease opioid consumption [7,9,13]. This is not surprising as lumbar plexus blocks offer ipsilateral analgesia without affecting the contralateral side, unlike lumbar epidurals, which may impede ambulation with bilateral lower extremity blockade.

As gabapentin and celecoxib were administered more often to lumbar plexus patients preoperative and on POD1, this is a limitation to our study and warrants further discussion. It may be hypothesized that these medications assisted in the transition from having a numb extremity to having a sensate extremity. Multi-modal pain management, including regional anesthesia, has been shown to improve pain control and accelerate functional recovery after THA [18–20]. However, multimodal regimens do not consistently decrease opioid consumption [18]. Consequently, our observations may more accurately indicate that a lumbar plexus peripheral nerve block may provide an effective alternative for analgesia in comparison to an indwelling epidural catheter; however, nonopiate analgesics may be required to optimize both opiate reduction and physical therapy initiation and progression.

Finally, it is notable that lumbar plexus nerve blocks did not delay discharge. Rather, discharge orders were written earlier in lumbar plexus block patients compared to patients with epidural analgesia. Marino et al also found that patients with lumbar plexus nerve blocks were ready for discharge earlier than those patients with continuous femoral nerve blocks or IV patient controlled analgesia opioids alone [13]. Although this trend could be for a multitude of reasons, early physical therapy and improved ambulation are likely contributing factors. As health care moves toward earlier patient discharge, our shorter block durations (whether epidural or lumbar plexus) and earlier physical therapy times are likely more applicable to current practice.

Limitations

This was a retrospective study subject to multiple limitations by design. We attempted to minimize any error in data collection by having multiple study personnel collect data on each subject. While our aim was to compare 2 different block types and demonstrate that the lumbar plexus peripheral nerve block was an effective technique in comparison to an indwelling epidural catheter, we found that gabapentin and celecoxib were administered more often to lumbar plexus patients and this is a limitation. Although future studies should compare these 2 block techniques with standardized nonopiate analgesic regimens, our data still indicate that lumbar plexus blocks are effective alternative to an indwelling lumbar epidural catheter. In addition, while we reported the rate of urinary catheter placement, we are not truly able to report the incidence of urinary retention in our cohort.

Conclusions

Lumbar plexus blocks appear to be an effective alternative to lumbar epidurals for postoperative analgesia following THA. In addition, lumbar plexus blocks may better facilitate immediate postoperative physical rehabilitation while permitting pharmacologic VTE prophylaxis.

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Fig. 1.
Study overview.

Fig. 2.

Cumulative opioid consumption over time. Opioid consumption was decreased at 24, 36, and 48 hours postoperatively in patients with lumbar plexus blocks compared with lumbar epidurals. The dark line represents median opioid consumption in intravenous morphine equivalents (mg). Boxes represent the 25th–75th percentile for each group. Whiskers extend to 1.5 times the interquartile range from the 25th–75th percentile. * $P < .05$; ** $P < .01$ (both after adjusting for multiple comparisons).

Fig. 3.

Distance ambulated by patients on each postoperative day (POD). Patients with a lumbar plexus block ambulated farther than patients with epidurals at all examined time points. The dark line represents the median distance ambulated (feet). Boxes represent the 25th–75th percentile for each group. Whiskers extend to 1.5 times the interquartile range from the 25th–75th percentile. * $P = .001$; ** $P < .001$.

Table 1

Patient Characteristics and Analgesic Consumption.

Variable	Epidural (n = 58)	Lumbar Plexus (n = 58)	P
Age (y)	61.3 (1.99)	60.4 (4.50)	.746
Gender (male)	29 (50.0)	23 (39.7)	.263
Race (white)	47 (81.6)	45 (77.8)	.647
OR time (min)	155.6 (7.45)	168.8 (3.70)	.116
General anesthesia	53 (91.4)	52 (89.7)	.751
Urinary catheter	58 (100.0)	38 (65.5)	<.001
Cumulative opioid consumption (intravenous morphine equivalents; mg)			
0–12 h	30.2 (1.80)	30.1 (1.54)	.942
0–24 h	48.9 (2.58)	42.4(1.94)	.047
0–36 h	67.5 (3.50)	53.7 (2.56)	.002
0–48 h	81.3 (4.13)	64.8 (3.32)	.002

Continuous variables are reported as mean (standard error) and categorical variables are reported as n (%). OR, operating room.

Table 2

Nonopiate Analgesic Consumption Separated by Block Type.

Analgesic	Epidural	Lumbar Plexus	<i>P</i>
Preoperative			
Acetaminophen	1 (1.7)	48 (82.8)	<.001
Celecoxib	0 (0)	44 (75.9)	<.001
Gabapentanoid ^a	2 (3.5)	47 (81.0)	<.001
Postoperative			
Acetaminophen	54 (93.1)	57 (98.3)	.364
Celecoxib	0 (0)	39 (67.2)	<.001
Gabapentanoid ^a	3 (5.2)	50 (86.2)	<.001

^aGabapentanoids administered included both gabapentin and pregabalin.

Table 3

Multivariable Model of Cumulative Opioid Consumption in Intravenous Morphine Equivalents (mg).

Variable	Beta ^a	95% Confidence Interval	P
Intercept	68.5	55.9, 81.1	<.001
Epidural (vs lumbar plexus)	16.5	6.55, 26.4	.002
Time (48 h)			
12 h	-34.8	-40.1, -29.4	<.001
24 h	-22.4	-26.2, -18.3	<.001
36 h	-11.2	-13.4, -8.92	<.001
Block by time interaction (lumbar plexus × 48 h)			
Epidural, 12 h	-16.3	-23.9, -8.70	<.001
Epidural, 24 h	-9.98	-15.8, -4.21	.001
Epidural, 36 h	-2.66	-5.84, 0.53	.105
Age (1 y increase in age)	-0.22	-0.37, -0.07	.006
General anesthesia (vs spinal)	10.7	3.73, 17.6	.003

A positive value indicates increased opioid consumption compared to the reference value and a negative value indicates decreased consumption.

^aBeta values represent the change opioid consumption (mg) attributed to the give variable when controlling for other factors. A positive value indicates increased opioid consumption and a negative value indicates decreased consumption.

Table 4

Multivariable Model of Distance Ambulated (Feet).

Variable	Beta ^a	95% Confidence Interval	P
Intercept	18.5	−19.2, 56.1	.339
Lumbar plexus (vs epidural)	25.8	10.5, 41.2	.001
Time (vs postoperative day 0)			
Postoperative day 1	83.3	19.3, 147.4	.012
Postoperative day 2	170.1	88.3, 252.0	<.001
Male gender (vs female)	37.2	21.8, 52.7	<.001
Age (1 y increase in age)	−0.32	−0.88, 0.25	.278
Lumbar plexus and time (vs epidural and postoperative day 0)			
Postoperative day 1	57.3	31.3, 83.4	<.001
Postoperative day 2	47.3	15.2, 79.4	.005
Male gender × time (vs female and postoperative day 0)			
Postoperative day 1	44.0	17.9, 70.2	.001
Postoperative day 2	47.5	15.0, 80.0	.005
Age × time (1 y increase in age and postoperative day 0)			
Postoperative day 1	−1.28	−2.25, −0.31	.011
Postoperative day 2	−2.07	−3.32, −0.82	.002

^aBeta values represent the change in the distance ambulated (feet) attributed to the give variable when controlling for other factors. Negative values indicate decreased distance and positive values increased distance ambulated.

Table 5

Variables Impacting the Level of Assistance in the Cumulative Logistic Regression Model.

Comparison	OR	95% Confidence Interval	P
Epidural (vs lumbar plexus)	2.53	1.26, 5.07	.009
Postoperative day			
Postoperative day 0 vs postoperative day 1	8.25	4.69, 14.5	<.001
Postoperative day 0 vs postoperative day 2	42.93	22.2, 83.2	<.001
Postoperative day 1 vs postoperative day 2	5.20	2.98, 9.09	<.001
African-American (vs Caucasian)	3.41	1.45, 8.03	.005
Females (vs males)	2.74	1.38, 5.44	.004
10-y increase in age	1.49	1.15, 1.92	.003
5-h increase in time to first ambulation	1.31	1.14, 1.51	<.001

Data are presented as odds ratios and 95% confidence intervals. Note that odds ratios represent the odds of needing more assistance.