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Effectiveness of local anesthetic injection in geriatric patients following operative management of proximal and diaphyseal femur fracture

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ABSTRACT

Introduction: Geriatric fracture patients are at risk for poorly controlled pain and side effects of opioid medications. The arthroplasty literature has demonstrated that infiltration of long-acting local anesthetic or anesthetic cocktails improves pain control and reduces post-operative opioid use resulting in better postoperative mobility without the deleterious effects of narcotics. Despite having a higher risk for adverse events, there is limited data among geriatric trauma patients. The aim this study was to evaluate whether local anesthetic infiltration (LAI) into the soft tissues surrounding the surgical field reduces narcotic use or pain scores in patients undergoing surgical management of proximal and diaphyseal femur fractures.

Materials and methods: A retrospective review was performed of patients age >65 undergoing operative intervention for proximal and diaphyseal femur fracture. The electronic record was utilized to determine if local anesthetic was injected into the surgical wound, the amount of narcotics administered over 48 h in four-hour intervals, and to obtain visual analog scale (VAS) pain scores associated with patients post-operative course in four-hour intervals. The amount of narcotics was converted to morphine milligram equivalents (MME).

Results: Among 477 patients with femur fracture, 358 did not receive LAI and 119 patients received LAI. Baseline demographics, fracture types, and surgical procedure were equivalent between the groups. In the first 28 h following surgery, compared with those who did not receive LAI, those who did required significantly less opioid (57.8 MME versus 94.3 MME, $p = 0.034$) and despite decreased narcotics, had equal pain scores (mean difference 0.37, $p = 0.22$). There was no difference in rates of post-operative complications.

Conclusion: LAI is associated with a reduction in opioid consumption in geriatric fracture patients with equivalent pain scores. Optimizing pain control is a critical issue in caring for geriatric fracture patients since both under-treated pain and opioid medications are implicated in postoperative delirium, complications, and ability to mobilize early. More research is needed to identify effective ways to optimize pain management in this at-risk patient population.

Introduction

Geriatric patients are at high risk of falls secondary to imbalance, weakness, higher prevalence of dementia, and medical co-morbidities frequently resulting in fracture. Mobility is critical to optimize healing and minimize loss of bone and muscle mass following fracture. However, the most common reason why many patients are unable to participate is poorly controlled pain [1]. Geriatric patients are at high risk of developing post-operative delirium which is multifactorial in etiology, including anesthetic agents, poly-pharmacy, being in unfamiliar surroundings, and pain medications [2–6,29–34]. However, it is clear that after fracture both the experience of pain itself as well as opioid analgesic medication used to treat pain are important contributors to postoperative delirium. Further medical co-morbidities such as renal, hepatic, and coronary disease can limit what multi-modal oral and intravenous medications may be utilized for pain control.

Several level 1 studies in arthroplasty patients have demonstrated that injection of local anesthetic or cocktails of several pain medications into the joint capsule and soft tissue may decrease narcotic utilization post-operatively [7–23]. Furthermore, injection

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of local anesthetic into the operative field has no increased risk of infection, bleeding, or other post-operative complications. However, there is a general lack of integration of these techniques in geriatric trauma patients [24–28]. The goal of this study was to determine whether intra-operative injection of local anesthetic agents decreased narcotic consumption post-operatively in geriatric patients undergoing surgical treatment for proximal and diaphyseal femur fractures.

Methods

Following institutional review board (IRB) approval, a retrospective review of medical records at the author's institution was undertaken. Patients age ≥65 years old who sustained femur fractures that underwent operative intervention from January 2014 to June 2017 were included in the cohort. CPT codes 27235, 27236, 27244, 27245, 27506 were used to identify patients undergoing operative repair of proximal and diaphyseal femur fractures. All procedures were performed by board certified orthopaedic surgeons. Patients were excluded for pathologic fracture, periprosthetic fracture, return to OR within 48 h post-operatively, admission to ICU with narcotic infusion for sedation/analgesia, spinal anesthesia, pre-operative regional block, or multiple fractures.

The medication administration record (MAR) was utilized to determine whether a patient received local anesthetic intra-operatively into the surgical field and what type of local anesthetic was utilized. While we acknowledge the potential for selection bias in any retrospective study such as this, the decision to utilize local anesthesia intraoperatively was up to the discretion of the treating surgeon and was based on surgeon preference and not any specific patient factors, medical, or psychiatric comorbidities. When local anesthetic was used in hemiarthroplasty, it was injected within the joint capsule, iliotibial (IT) band, subcutaneous tissue, and the dermis. When the joint capsule did not require exposure, such as intramedullary nailing or percutaneous screw fixation, the periosteum, IT band, subcutaneous tissue, and the dermis were injected with local anesthetic.

The primary outcome measure was quantity of narcotic medication needed post-operatively, reported in milligram morphine equivalents (MME). The MAR was used to determine the dosage of narcotic medications dispensed over the first 48 h post-operatively that were subsequently converted into MME. The MME were divided into four-hour increments to better assess the timing of narcotic consumption between groups. Secondary outcome measures included hospital length of stay, VAS pain scores over the first 48 h, admitting hospital service, and 30-day complications including readmission, reoperation, and significant medical events. Incidence of baseline dementia or subsequent development of delirium while admitted to the hospital were not specifically investigated as a manual review of charts demonstrated inconsistency with documentation or criteria for documentation of delirium or dementia.

Statistical analyses were conducted with the R statistical software package (v3.3.2). Analyses were conducted to identify individual factors associated with intraoperative injections. For continuous variables, Student's *t*-tests were used to compare patients who received intraoperative injections to those that did not. Chi-square tests were used to compare the differences in categorical variables relative to intraoperative injections.

Univariate analyses were conducted to assess the association between total MME used in the first 24 h and outcome variables. Follow-up multivariate models were conducted, using each variable identified as a significant association in the univariate models, to assess the factors associated with MME used in the first 24 h.

Results

477 patients were identified who fit the above criteria. 118 (24.7%) patients received intra-operative LAI while 359 (75.3%) patients did not. Age, sex, Charleston comorbidity index (CCI), proportion of fracture type, and surgical procedure were similar between the two groups (Table 1). The mean amount of local anesthetic infiltrated was 77 mg (standard deviation 48 mg).

The benefit of LAI was seen in the first 4 h in those patients receiving LAI received 14.03 MME compared to 41.91 MME in those receiving no LAI (p = 0.0039). The decreased narcotic utilization continued to be statistically significant for the first 28 h post-operatively; LAI 57.82 MME compared to 94.31 MME in those receiving no LAI (p = 0.034) (Fig. 1). From 28 to 48 h post-operative, there was no statistical difference in MME between the groups.

Table 1
Demographics, injury characteristics.

	Intraoperative injection (n = 118)	No injection (n = 359)	p-value
Age, mean (SD)	83.75 (8.74)	82.80 (8.78)	0.31
Sex Male, n (%)	38 (32.2)	104 (29.0)	0.59
Fracture type			0.99
Femoral neck, n (%)	51 (43.2)	155 (43.2)	
Intertroch, n (%)	56 (47.5)	172 (47.9)	
Subtroch, n (%)	8 (6.8)	22 (6.1)	
Femoral shaft, n (%)	3 (2.5)	10 (2.8)	
Procedure			0.84
Hemi, n (%)	36 (30.5)	105 (29.2)	
CRPP, n (%)	19 (16.1)	49 (13.6)	
SHS, n (%)	26 (22.0)	72 (20.1)	
CMN, n (%)	30 (25.4)	110 (30.6)	
IMN, n (%)	7 (5.9)	23 (6.4)	
Hospital service			0.92
Hospital medicine, n (%)	102 (86.2)	310 (86.4)	
Ortho, n (%)	10 (8.5)	26 (7.2)	
General surgery, n (%)	5 (4.2)	18 (5.0)	
Other, n (%)	1 (0.8)	5 (1.4)	
Transfusions RBC (units), mean (SD)	0.78 (1.47)	0.54 (1.02)	0.05
Operative time (hr), mean (SD)	1.22 (0.61)	1.06 (0.53)	0.005
LOS (days), mean, (SD)	7.05 (6.22)	6.39 (8.4)	0.44
CCI, mean, (SD)	2.54 (2.86)	2.42 (2.55)	0.65

CRPP = Closed reduction percutaneous pinning, SHS = sliding hip screw, CMN = cephalomedulary nail for intertrochanteric fracture, IMN = intramedullary nail, POD = post-op day, RBC = red blood cells, LOS = length of stay, CCI = Charleston co-morbidity index.

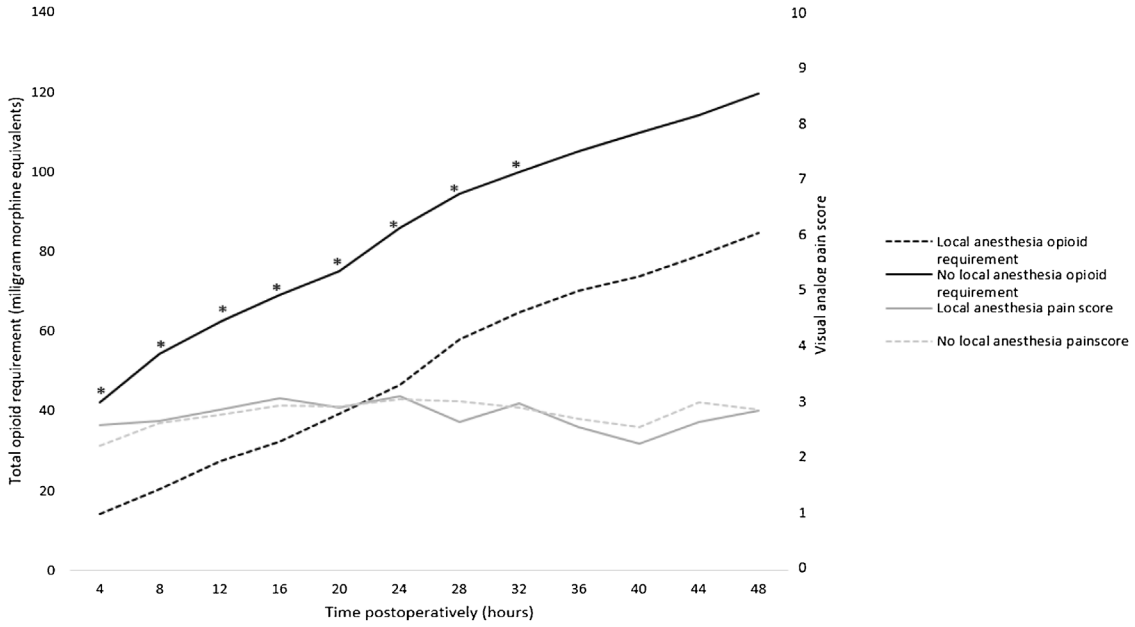

Fig. 1. Cumulative postoperative opioid requirement and postoperative visual analog pain scores.
* Represents statistically significant difference ($p \leq 0.05$) between opioid requirement with and without local anesthesia.

There was no statistical difference in hospital length of stay between the LAI and non-LAI groups (7.05 days versus 6.40 days, p = 0.369). Post-operative 30 day complications were equivalent between the LAI and non LAI groups respectively in regards to venothromboembolic event (3 events (2.5%) versus 10 events (2.8%), p = 1), myocardial infarction (7 events (5.9%) versus 11 events (3.1%), p = 0.254), surgical site infection (1 event (0.8%) versus 3 events (0.8%), p = 1), and stroke (11 events (9.3%) versus 11 events (5.0%), p = .132) (Table 2). VAS pain scores, as recorded by nursing staff, were not statistically significant during the 48 h post-operatively (Fig. 1).

Multivariate analysis (Table 3) demonstrated a significant negative association between age and MME usage (Est. = –6.31, SE = 1.17, p < 0.001). Receiving LAI also demonstrated a strong negative association with MME utilization (Est. = –42.55, SE = 21.94, p = 0.053). Admission to an orthopaedic surgery hospital service was positively associated with increased MME consumption (Est. = 77.16, SE = 38.54, p = 0.045). Patients sustaining a subtrochanteric femur fracture were also observed to have a positive associated with MME use (Est. = 92.95, SE = 40.47, p = 0.022).

Table 3
Multivariate analysis evaluating whether there is an association between narcotic administrations within the first 24 h postoperatively and local anesthetic administration after controlling for potential cofounders.

MME 0–24 h	Estimate	STD Error	p-value
Age	−6.31	1.17	<0.001
Fracture type			
Femoral neck	REF	REF	REF
Intertroch	31.45	19.73	0.11
Subtroch	92.95	40.47	0.02
Femoral shaft	−38.45	62.25	0.54
Operative time	49.74	18.00	0.006
Received local anesthesia	−42.55	21.94	0.05
CCI	−1.74	3.65	0.63
Hospital service			
Hospital medicine	REF	REF	REF
Orthopedics	77.16	38.54	0.05
General surgery	70.85	46.08	0.12
Other	−24.50	84.28	0.77

CCI = Charleston comorbidity index.

Discussion

Treatment of pain is particularly challenging among geriatric patients who are at increased risk of delirium as a result of both uncontrolled pain as well as opioid medication administration. Delirium is present in 30% of older hospitalized adults and is associated with poor short and long-term functional outcomes including functional decline, sustained cognitive impairment, increased hospital length of stay and higher mortality. Furthermore, poorly controlled pain following proximal femur fracture is also associated with longer hospital stays, delayed walking and post-operative complications [35,36]. As a result of the adverse consequences associated with both poorly controlled pain as well as opioid pain medications, particularly in the elderly, there has

Table 2
Outcomes (univariate analysis).

	Intraoperative injection (n = 118)	No injection (n = 359)	p-value
Hospital LOS, mean (SD)	7.046 (6.22)	6.395 (8.39)	0.37
VTE, n (%)	3 (2.5)	10 (2.8)	1
MI, n (%)	7 (5.9)	11 (3.1)	0.25
SSI, n (%)	1 (0.8)	3 (0.8)	1
Stroke, n (%)	11 (9.3)	11 (5.0)	0.13
90 day readmission, n (%)	16 (13.6)	43 (12.0)	0.77
90 day reoperation, n (%)	1 (0.8)	16 (4.5)	0.12

LOS = length of stay, VTE = venothromobembolic events, MI = myocardial infarction, SSI = surgical site infection.

been increasing emphasis on multimodal pain regimens, particularly among elective orthopaedic patients. However, data on the value of multimodal analgesia following surgery for orthopaedic trauma is less well established.

The present study demonstrates that intraoperative local anesthesia results in a substantial reduction in narcotic utilization within the first 24 h after surgery, with equivalently adequate pain control as measured by the VAS pain scale. During that initial 24 -h period patients who received intraoperative local anesthesia required approximately half the amount of morphine equivalents compared to those who did not receive any local anesthesia. Multivariate analysis demonstrated an independent negative association between receiving local anesthesia and need for narcotic pain medication, even after controlling for age, fracture type, operative time, comorbidities and hospital service patient was admitted to.

This early benefit to local anesthetic infusion around the surgical site ultimately results in early, clinically relevant difference in need for pain medication. In this study, this appeared to be a safe modality for alleviating pain without any increased complications. Prior studies assessing plasma concentrations of ropivacaine following soft tissue injections demonstrated that no patients reached intravascular concentrations that would be toxic [7,8,18]. Given what is known about downstream effects of narcotic medication, particularly in the elderly, this reduction in narcotic pain medicine is of substantial relevance. This is particularly the case given the low cost and significant ease associated with infusing local anesthesia at the surgical site.

Pre-operative regional blocks, epidurals, and infusion catheters have also been shown to be effective at alleviating pain and delirium. However these interventions result in diminished motor control with increased fall risk post-operatively, decreased time to mobility, and with prolonged time to meeting physical therapy milestones [37–45]. This ultimately could delay discharge from the hospital and increase health care dollars spent. The utility of these interventions also depend on emergency medicine and anesthesia capabilities and may not be available to all orthopaedic providers.

Reducing narcotic consumption is one of the overarching goals of multimodal pain management. Previous studies have been performed investigating the utility of local anesthetic injection for post-operative analgesia. Multiple studies in the arthroplasty literature supports use of multiple injections for patients undergoing total hip and total knee replacement and shows decreased use of narcotics [8–13,17–23,46]. In two recent studies bupivacaine and also a bupivacaine/clonidine/toradol cocktail have been compared to liposomal bupivicaine and found to be equivalent with no difference in pain control, use of narcotics, or mobility [47–50]. Peri-articular injections in arthroplasty patients in two recent meta-analyses have been demonstrated reduction of narcotic use and subsequent decrease in narcotic related side effects including nausea, emesis, rash, and pruritus [20,22]. These data have led to the inclusion of multimodal local anesthetic injections into the standard of care for arthroplasty.

In trauma patients, Koehler et al. [51] demonstrated lower VAS pain scores in the first 12 h post-operative and less narcotic use in the first 8 h post-operative following injection of bupivacaine, epinephrine, and morphine into the soft tissues of femur fracture patients. The study also demonstrated delirium of 2.2% in those with LAI versus 9.1% in those patients without LAI. This was a heterogeneous group of patients with femoral fracture in any anatomic region and in all adult patients $\geq$18 years old. Kang et al. [23] investigated the combination of ropivicaine, epinephrine, morphine, ketorolac, and cefmetazole and immediate pre-operative use of oxycodone and celecoxib for patients undergoing hip hemiarthroplasty following femoral neck fracture. Patients receiving LAI and pre-operative PO medications had lower VAS pain scores at days 1 and 4 post-operative and also received 59% less narcotics than those not receiving LAI.

This study is limited by the context of its design. This is a retrospective analysis and as a result causation cannot be assumed and only associations can be identified. Further prospective studies are needed to clarify the causative association between intraoperative local anesthesia and pain control/need for opioid pain medications. Furthermore, the potential for selection bias must also be considered. At this institution, there are specific surgeons who always use local anesthesia and some surgeons who are not consistent with their use or disuse of local anesthesia. The rationale for which patients receive local anesthetic in the latter cases is uncertain but could introduce bias. However, there were no differences between demographics and/or injury-specific variables between the two groups. The study population included a heterogeneous group of fracture types and surgical interventions. If one surgical intervention or injury was more painful than another it might bias the results. However in our study, there was similar distribution of fracture type and surgical procedures between the two groups. Furthermore, multivariate analysis was performed demonstrating independent association between local anesthetic administration and need for opioid medications even after controlling for this potential cofounder. Due to the retrospective nature of the study, we were limited to data collected as part of the medical record. Because delirium was poorly recorded in the medical record we were unable to directly investigate the effect of LAI on delirium. Post-operative pain levels determined by VAS are subjective and may be influenced by multiple factors including psychological, culture, personal experience, and operative technique. Future prospective studies are needed to better clarify these relationships.

Conclusion

In conclusion, our results suggest that the use of intra-operative local anesthetic injection in geriatric patients who have sustained proximal femur fracture is safe and effective at reducing post-operative narcotic utilization with equivalent VAS pain scores.

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Declaration of Competing Interest

No relevant conflicts of interest for any of the authors.

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