Palliative Management of Nonoperative Femoral Neck Fractures With Continuous Peripheral Indwelling Catheters: Case–Control Series

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Abstract
Introduction: This case–control study evaluates the success of indwelling pain catheters in nonoperatively treated femoral neck fractures (FNFs) for end-of-life pain management. Methods: Patients older than 65 years with nonoperatively treated FNFs were retrospectively identified at a level 1 trauma center between March 2012 and September 2015. Twenty-three received indwelling continuous peripheral pain catheters (experimental) and 10 received traditional pain control modalities (control). Pain scores 24 hours before/after pain management interventions, ambulation status at admission and discharge, mortality at 30 days/1 year, and length of hospital stay (LOS) were compared between treatment groups. Results: The experimental and control groups were similar with respect to demographics, differing only in pre-fracture ambulatory status (P = .03). The 30-day mortality was 52% versus 50% (odds ratio, OR: 1.1 [95% confidence interval, CI: 0.25-4.82], P = .99) and 1-year mortality was 87% versus 80% (OR: 1.67 [95% CI: 0.23-11.9], P = .63) for experimental and control groups, respectively. The LOS did not statistically significantly differ for experimental and control groups (5.3 ± 3.56 days vs 3.8 ± 1.81 days, P = .15), respectively. The experimental group experienced twice the improvement in ambulation status (1.0 ± 0.56 vs 0.5 ± 0.71, P = .03) and greater improvement in pain scores (4.5 ± 2.19 vs 1.2 ± 2.72, P = .002). Discussion: Operative management of FNFs may not be indicated in patients with advanced age and comorbidities. Regardless, these patients require pain palliation and early mobilization while minimizing hospital LOS and opiate consumption. Conclusion: This case–control study demonstrates significant improvement in both pain level and ambulatory status for patients treated with indwelling continuous peripheral catheters. Future studies should further evaluate with a larger sample size; however, this study provides an excellent launching point for palliative management of this complex population.

Keywords
femoral neck fractures, osteoporosis, palliative management, pain catheter

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surgical intervention as the gold standard for geriatric FNFs, a small subset of patients will proceed with nonoperative management either as a result of personal choice or because operative management is contraindicated. Consequently, current hospice patients, patients with preexisting comorbidities, and patients with minimal baseline ambulatory level present a challenge to orthopedic surgeons and geriatricians.

Geriatric patients sustaining FNFs electing for palliative, nonoperative management are typically treated with systemic opiate pain medication until the formation of a functional girdlestone. Maintaining aggressive mobilization during this time is imperative and directly correlated with survival. However, successful mobilization is contingent on adequate pain management and ideally involves a multimodal approach. Opioid usage in this population is problematic and has been shown to exacerbate cognitive impairments, worsen acute delirium and potentially increase the probability of additional falls. Thus, there exists a clinical need for adjunct medication in patients undergoing nonoperative management for FNFs. The advent of continuous indwelling analgesic catheters provides a feasible adjuvant to pain management in this cohort. Pain management via indwelling peripheral nerve sheath catheters has demonstrated efficacy within upper extremity surgery, joint arthroplasty, and nonorthopedic surgical procedures. To our knowledge, pain management via peripheral or intracapsular catheters in patients with nonoperatively managed FNF has not yet been described in published literature.

This case–control study sought to identify the efficacy of indwelling catheters to palliate patients with FNFs treated nonoperatively. Ropivacaine catheters intended to supplement our institution’s traditional multimodal pain management protocol, which includes acetaminophen, anti-inflammatories, and opiates. We compared pain scores, ambulatory level, 30-day and 1-year mortality, and length of hospital stay (LOS) between patients of a previously reported case series and a control group. In addition, we sought to quantify the percentage of patients at our institution who undergo nonoperative management.

Methods

A retrospective chart review was performed at a level 1 trauma center from March 2012 to September 2015 to identify patients at least 65 years of age who sustained FNFs from March 2012 to September 2015. To be eligible for inclusion in the study, patients must have sustained an FNF with Orthopaedic Trauma Association classification 31-B1, 31-B2, and 31-B3 that was treated nonoperatively. Patients with cognitive impairment that prevented them from reporting pain levels on a visual analog pain scale were excluded.

Qualifying patients were identified by first using the appropriate International Classification of Diseases, Ninth Edition codes for FNF. The resulting list of patients was then queried for Common Procedural Terminology (CPT) codes indicative of operative management; operatively managed patients were excluded. To define the experimental treatment group, the resulting list of patients was queried for the CPT codes indicating placement of continuous ropivacaine analgesic catheters which were intracapsular blocks, peripheral nerve blocks, or a combination of both. Patients receiving indwelling catheters comprised the experimental group, and all the remaining patients treated with traditional pain management modalities served as controls.

After satisfying eligibility criteria, patient charts were reviewed to obtain basic patient demographics, past medical history, mortality at 30 days and 1 year, and LOS. Any preexisting chronic disease conditions were noted. Chronic diseases of interest included cardiac disease, peripheral vascular disease, diabetes mellitus, hypertension, hyperlipidemia, chronic kidney disease, chronic obstructive pulmonary disease, or atrial fibrillation. These morbidities were chosen because they were end-stage organ system diseases or conditions that would facilitate the development of such conditions.

For the experimental group, we collected the mean VAS 24 hours before/after continuous pain catheter placement and ambulation status before and after continuous pain catheter placement. For the controls, we collected the mean VAS 24 hours after the first recorded administration of opioid pain medication. Ambulatory status was recorded on admission and prior to discharge. Improvements in ambulatory status from admission to discharge were assessed by quantifying each ambulatory functional level with a 0, 1, or 2 to indicate bedrest, transfer to chair, and walker, respectively. The ambulatory status score at admission was subtracted from ambulatory status score at discharge to determine improvement.

Each group was assessed for statistically significant differences in both demographic information and outcome measures using a Fisher exact test for categorical data or an independent or paired samples t-test for continuous data. The level of statistical significance was set a priori at .05.

Results

Of the 507 patients sustaining FNFs between March 2012 and September 2015, 33 were treated nonoperatively, reflecting a 6.5% rate of nonoperative management. Overall, 20 of the 33 patients were contraindicated for surgical intervention, while the remaining 13 were recommended for operative treatment, but elected to proceed with nonoperative management. Twenty-three patients were augmented with indwelling catheters (experimental group), while the remaining 10 patients were treated nonoperatively with traditional pain management modalities (controls).

The experimental and control groups did not statistically significantly differ with respect to sex, mean age, coronary artery disease/peripheral vascular disease, diabetes mellitus, hypertension, hyperlipidemia, chronic kidney disease, chronic obstructive pulmonary disease, atrial fibrillation, cognitive disorders, baseline pain level, reason for nonoperative management, or receipt of a palliative care consult (Table 1). However, a Fisher exact test revealed that the groups statistically significantly differed with respect to ambulatory status. The control group had a statistically significantly larger proportion of home ambulators when compared to the experimental group, $\chi^2 (1) = 8.29, P = .007$ (Table 2). There was no statistically significantly different in LOS between the experimental group and the control group ($5.3 \pm 3.56$ vs $3.8 \pm 1.81$, $P = 0.15$).
Although the control and experimental groups did not differ significantly with respect to baseline pain level, the experimental group experienced a statistically significantly greater improvement in mean pain score, \( t(27) = 3.42, P = .002 \) (Table 3). The experimental group also experienced a statistically significantly greater improvement in ambulatory status, \( t(31) = 2.36, P = .03 \) (Table 3). There was no statistically significant difference between groups with respect to 30-day or 1-year mortality (Table 3).

### Discussion

Operative management remains the gold standard for improving both pain and function; however, there are patients who opt not to have surgery or who have sufficient comorbidities that surgical risk is high enough to make operative fixation absolutely or relatively contraindicated. Nonetheless, this patient population requires palliation of pain and early mobilization.1,5-10 As both frequency of FNFs and life expectancy continue to increase, orthopedic surgeons can expect to manage patients who refuse or cannot tolerate surgical management, posing a challenge to both orthopedic surgeons and geriatric hospitalists. This study demonstrates that pain and early ambulation can be improved with the use of catheters without statistically significantly increasing the LOS. To our knowledge, this is the first case–control study that describes pain management of nonoperatively treated FNF with continuous analgesic pain catheters as an augment to traditional pain management techniques.

| Table 1. Basic Demographic Information and Statistical Comparisons Between Control and Experimental Groups.\(^a\) |
|-------------------------------------------------|-----------------|-----------------|-----------------|
| | Control (%) | Experimental (%) | OR (95% CI) | \( P \) |
| Gender | | | | |
| Male | 6 (60) | 6 (26) | 0.24 (0.05-1.1) | .11 |
| Female | 4 (40) | 17 (74) | | |
| Ambulation status | | | | |
| Minimal | 0 (0) | 6 (26) | | |
| Transfer to chair | 1 (10) | 9 (39) | | |
| Home ambulator | 8 (80) | 6 (26) | | |
| Nonambulatory | 1 (10) | 2 (9) | | |
| Baseline pain level | 6.7 ± 1.05 | 6.8 ± 1.42 | (2.1-2.4) | .90 |
| Reason for nonoperative management | | | | |
| Contraindicated | 5 (50) | 15 (65) | 0.53 (0.12-2.4) | .68 |
| Choice | 5 (50) | 8 (35) | | |
| CAD/PVD | | | | |
| Yes | 7 (70) | 14 (61) | 0.67 (0.14-3.3) | .71 |
| No | 3 (30) | 9 (39) | | |
| DM | | | | |
| Yes | 1 (10) | 7 (30) | 3.9 (0.42-37.3) | .38 |
| No | 9 (90) | 16 (70) | | |
| HTN | | | | |
| Yes | 7 (70) | 16 (70) | 0.98 (0.19-4.9) | .99 |
| No | 3 (30) | 7 (30) | | |
| HLD | | | | |
| Yes | 6 (60) | 8 (35) | 0.36 (0.08-1.6) | .26 |
| No | 4 (10) | 15 (65) | | |
| CKD | | | | |
| Yes | 4 (10) | 9 (39) | 0.96 (0.21-4.4) | .99 |
| No | 6 (60) | 14 (61) | | |
| COPD | | | | |
| Yes | 5 (50) | 4 (17) | 0.21 (0.04-1.1) | .09 |
| No | 5 (50) | 19 (83) | | |
| AF | | | | |
| Yes | 2 (20) | 8 (35) | 2.1 (0.36-12.5) | .68 |
| No | 8 (80) | 15 (65) | | |
| Cognitive disorder | | | | |
| Yes | 7 (70) | 15 (65) | 0.80 (0.16-4.0) | .99 |
| No | 3 (30) | 8 (35) | | |
| Palliative consult | | | | |
| Yes | 4 (40) | 12 (52) | 1.6 (0.36-7.4) | .71 |
| No | 6 (60) | 11 (48) | | |

Abbreviations: AF, atrial fibrillation; CI, confidence interval; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HLD, hyperlipidemia; HTN, hypertension; OR, odds ratio; PVD, peripheral vascular disease.

*Bolded \( P \) values indicate statistical significance.
The pain produced by an FNF can be debilitating as evidenced by the 33 study patients who were confined to bedrest immediately following injury. Although opiates can control pain exceedingly well, they have a high side effect profile, particularly in the geriatric population. Opiates have been proven to further exacerbate baseline cognitive disorders, a potentially devastating outcome for the 66% of patients in our study with cognitive disorders. Thus, unnecessary palliation with opioids should be avoided whenever possible. Prior studies have demonstrated the efficacy of continuous pain catheters in preoperative pain management. Likewise, extrapolating this technology to geriatric patients with FNFs has demonstrated excellent pain control as evidenced by the mean reduction of 4.3 in VAS scores within 24 hours of catheter placement. This represents nearly a 65% decrease in pain levels, which can consequently decrease consumption of opiates.

Patients who remain bedridden are more likely to have negative outcomes secondary to decubitus ulcers, aspirations, and pulmonary decline. Given the ~65% pain reduction in the experimental group, it is not surprising that improvement in ambulatory status was more than twice that of the control group when comparing ambulation status 24 hours after pain catheter placement versus discharge ambulation level for patients who did not receive the adjunctive therapy.

Despite the similarity of 30-day/1-year mortality rates and LOS between groups, the difference in VAS scores between groups demonstrates that all patients treated with indwelling catheters for their FNFs were more comfortable during their hospital stay. Overall, our patients demonstrated a shorter LOS at 5.3 and 3.8 days (experimental vs control, respectively) when compared with the 2010 national average of 5.8 days for all FNFs reported by the CDC. Although this case–control series of patients demonstrated improved pain scores and decreased LOS, 30-day mortality and 1-year mortality were staggering. We attribute this to 2 potential causes. First, the high incidence of comorbidities in our patient population may contribute to a higher likelihood of mortality independent of how the FNF was managed. This rationale is echoed by the work of Ooi et al, who in their study of nonagenarians, showed similar mortality of patients treated both operatively and nonoperatively for proximal femur fractures. Conversely, one could argue that mortality rate was so strikingly high solely as a result of nonoperative treatment. However, despite foregoing operative treatment, 87% of patients were (at minimum) able to ambulate to a chair and 17.4% were able ambulate a distance. In a Cochrane review, Parker et al obtained similar results, finding that there was no difference in hip fracture–related mortality between those

### Table 2. Pairwise Comparisons for Each Ambulation Status to Determine the Direction of Statistical Significance

| Ambulation status | Control (%) | Experimental (%) | OR (95% CI)   | P   |
|-------------------|-------------|------------------|---------------|-----|
| Minimal vs others |             |                  |               |     |
| Minimal           | 0 (0)       | 6 (26)           | 5.8 (0.62-53.7) | .15 |
| Other             | 10 (100)    | 17 (74)          |               |     |
| Transfer vs others|             |                  |               |     |
| Transfer          | 1 (10)      | 9 (39)           | 0.09 (0.01-0.54) | .12 |
| Others            | 9 (90)      | 14 (61)          |               |     |
| Home ambulator vs others | |                  |               |     |
| Home              | 8 (80)      | 6 (26)           | 0.86 (0.07-10.7) | .007|
| Others            | 2 (20)      | 17 (74)          |               |     |
| Non-ambulatory vs others | |                  |               |     |
| Nonambulatory     | 1 (10)      | 2 (9)            | 0.63 (0.47,0.84) | .99 |
| Others            | 9 (90)      | 21 (91)          |               |     |

*Bolded P-values indicate statistical significance.

### Table 3. Statistical Comparison of Outcomes of Interest between Control and Experimental Groups

|                  | Control (%) | Experimental (%) | OR (95% CI) | P   |
|------------------|-------------|------------------|-------------|-----|
| Improvement in pain score | 1.2 ± 2.72 | 4.5 ± 2.19 | (1.30-5.18) | .002|
| Improvement in ambulation status | 0.5 ± 0.71 | 1.0 ± 0.56 | (0.07-1.0) | .03 |
| LOS              | 3.8 ± 1.81  | 5.3 ± 3.56       | (0.93-3.9) | .15 |
| 30-day mortality |             |                  |             |     |
| Yes              | 5 (50)      | 12 (52)          | 1.1 (0.25-4.82) | .99 |
| No               | 5 (50)      | 11 (48)          |             |     |
| 1-year mortality |             |                  |             |     |
| Yes              | 8 (80)      | 20 (87)          | 1.67 (0.23-11.9) | .63 |
| No               | 2 (20)      | 3 (13)           |             |     |

Abbreviations: OR, odds ratio; CI, confidence interval; LOS, length of hospital stay.
treated with and without surgery. Additionally, Raaymakers and Marti reported only a 16% mortality rate at 1 year in patients with impacted FNFs treated with nonoperative management and early mobilization.11

We acknowledge several limitations. The most noteworthy of which is the small, single-institution patient subset, which we consider inevitable, as our institution observes a nonoperative management rate of just 6.5%. This percentage is relatively consistent with previous studies, which reported that between 2% and 10.3% of FNFs were treated nonoperatively.28,29 Second, we acknowledge that by excluding demented patients, we have eliminated a sizeable subset of patients who sustain FNFs. Future studies can assess pain levels using scales designed for use in demented patients such as the Pain Assessment in Advanced Dementia Scale.

Our study was also limited by its case–control design. Most notably, we recognize the potential for selection bias and observation bias inherent in case–control studies. Furthermore, the unequal sizes of the control and experimental groups reduce the reliability of the statistical analysis; a larger control group would allow for a higher possibility of attaining a significant difference between 30-day/1-year mortality and LOS. Future studies should ideally evaluate more patients from multiple institutions to obtain more generalizable results. A final consideration is the potential difference in outcomes resulting from variability in catheter placements (intracapsular blocks vs peripheral nerve blocks vs a combination of both). Although at our institution, peripheral and intracapsular nerve blocks are both ultrasound and nerve guided, the complex innervation of the hip joint may introduce the possibility for variation in the type of nerve block selected. It is possible that our failure to distinguish between the patients receiving the peripheral and the intracapsular catheters may have had distinguishable differences in pain or complication rates. As operative management of our patient population continues to be complicated by advanced age and comorbid conditions, nonoperative management of hip fractures is likely to become more commonplace. As such, it will become increasingly important to elucidate the safest, most efficacious palliation method for these patients. Opportunities for further exploration should involve distinction between catheter type/placement and controls receiving our institution’s traditional treatment modality.

Conclusion

This case–control series provides orthopedic surgeons with data to support the noninferiority of this adjunct to palliate patients who are not candidates for surgical management of their FNFs. In addition, it quantifies the patients requiring nonoperative management at a level 1 trauma center and the demographics that may assist orthopedic surgeons in identifying patients who would benefit from a palliative care referral. As the geriatric population and life expectancy continue to rise, orthopedic surgeons will be more frequently involved with end-of-life care in patients with FNFs. This study provides a successful augment that demonstrates excellent pain control and helps improve patient ambulation status to ultimately improve comfort at the end of life.

Declaration of Conflicting Interests

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