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A Prospective Review of Hip Fracture Subtypes, Surgical Procedure, Cognitive Status, and Analgesia Use Across 4 Australian Hospitals

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Abstract

Objectives: To correlate analgesia use among patients with hip fracture requiring surgery with hip fracture subtype, cognitive status, and type of surgery in the postacute period. *Design and Participants:* Prospective review of patients with hip fractures requiring surgical intervention. A total of 415 patients (mean age: 81.2 $\pm$ 9.1 years, 74.3% women) presented with 195 subcapital fractures (39 undisplaced, 156 displaced) and 220 trochanteric fractures (136 stable, 84 unstable) requiring surgery. *Setting:* Inpatient orthopedic units in 4 Australian hospitals. *Measurements:* The primary outcome measures were mean analgesia usage (oral morphine equivalent) for 4 defined time intervals and total amount 36 hours following surgery. *Results:* Patients with subtrochanteric fractures required more analgesia compared with displaced-subcapital, undisplaced-subcapital, basicervical, stable-pertrochanteric, and unstable-pertrochanteric fractures in the 24 to 36 hours following operation (24.7 vs 11.3 vs 8.8 vs 12.1 vs 7.6 vs 9.7, $P = .001$). Total analgesia requirements were higher in patients treated with an intramedullary nail, increasing by 1.3- to 3.3-fold in the 36 hours postsurgery. Patients with cognitive impairment utilized markedly less analgesia at all time periods measured. At 24 to 36 hours, higher levels of analgesia were noted in patients with higher premorbid level of mobility ($P = .015$) and activities of daily living function ($P = .007$). *Conclusion:* Important differences in utilization of analgesia following hip fracture across readily defined clinical groups exist. Proactive pain management for those with cognitive impairment, certain hip fracture subtypes, and surgical procedures may enable early functional mobility and other activities.

Keywords

fragility fractures, geriatric medicine, geriatric trauma, physical medicine and rehabilitation, trauma surgery

Introduction

Hip fractures are the most frequently seen serious injuries in patients admitted to hospitals.[1] By 2040, an estimated 512 000 hip fractures will occur in the United States each year at a cost of $16 billion per year,[2] and by 2050, an estimated 76.7 billion Euros in Europe.[3] One year after fracture, 37.1% of men and 26.4% of women will have died, compared with an expected annual mortality of about 10% in this age group.[4] More than 10% of survivors will be unable to return to their previous residence. Most of the remainder will have some residual pain or disability.[5]

Hip fractures are usually classified, according to anatomical location,[6] as being intracapsular, consisting of undisplaced subcapital (SC) [31-B1], or displaced SC according to Garden's classification system I-II or III-IV, respectively [31-B3],[7] or

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extracapsular (trochanteric fracture). The latter are classified into stable (2-part pertrochanteric [31-A1]) and unstable (3- or 4-part pertrochanteric, with disruption of the medial femoral cortex [31-A2]), and subtrochanteric [31-A3] according to the AO/OTA classification.[8] Basicervical fractures [31-B2.1] are extracapsular 2-part fractures, with the fracture plane running along the line of capsular insertion, just proximal to the lesser and greater trochanter.[9] Several recent studies of older adults in a postacute[10] and subacute setting[11] following hip fracture surgery have found that higher analgesic usage was required in patients with certain hip fracture subtypes and surgical procedures to enable active rehabilitation, and that cognitively impaired patients received significantly less analgesia. Furthermore, postoperative pain following hip fracture in older patients has been associated with increased length of stay, delayed ambulation, and long-term functional impairment,[12] and severe pain significantly increases the risk of delirium in cognitively intact patients.[13]

In order to validate the hypothesis that hip fracture subtype, cognitive status, and type of hip fracture surgery have a relationship with analgesia requirements, we performed a prospective study over several orthopedic sites across Australia exploring these factors.

Methods

Setting and Participants

The clinical records of patients with a hip fracture admitted to the orthopedic ward were reviewed (prospectively and done in real-time) by 4 research orthopedic surgical trainees (who identified the fractures) and 2 physicians over a 1-year period (January 2007 to December 2007) at 4 hospitals in Metropolitan Sydney (ranging from 320 to 454 beds) and on the Central Coast (484 beds), New South Wales, Australia. Fractures were identified by the treating orthopedic surgical trainees. The inclusion criteria were patients admitted with a hip fracture (excluding those related to pathological fractures, high-speed or multi-site trauma, or fall from greater than standing height) requiring surgical intervention. For each hospital site, the medical files for the admission were examined by 2 independent researchers. Data collection was performed with a structured form that elicited information about fracture history, surgical procedure, cognitive status, and type of analgesia provided. The study was approved by the relevant institutional ethics committees. Data from 1 site (n = 202) have been reported previously.[10]

Outcome Measures

Patients with hip fracture were reviewed for mean analgesia usage (oral morphine equivalent) for 4 defined time intervals (0-6, 6-12, 12-24, and 24-36 hours), and total amount in the 36 hours, following surgery. Each patient's total opioid analgesic regimen was determined by adding up the doses of all long-acting and short-acting opioid doses consumed, and the amount per time interval calculated accordingly.[14] If the patient was administered multiple opioids, we converted all to morphine equivalents using standard equi-analgesic tables to derive the total dose in morphine equivalents for each time period. We chose this method of converting all opioids to a total daily morphine equivalent as most equi-analgesic data presented in reference tables is derived from multiple studies that often used morphine as the sole comparator (ie, morphine to hydromorphone,[15] morphine to oxycodone,[16] and morphine to transdermal fentanyl[17]).

Descriptive statistics were calculated to describe demographic data (including age, sex, place of residence); clinical data (surgical procedure, type of intraoperative analgesia, prefracture and postfracture mobility status, and activities of daily living [ADLs] status via a simple 5-point scale according to whether assistance is required for bathing, dressing, toileting, getting from bed to chair, continence), hip fracture subtype according to anatomical location[18] (undisplaced SC, displaced SC, basicervical, stable pertrochanteric [2-part], unstable pertrochanteric [3- or 4-part, with disruption of the medial cortex], or subtrochanteric fracture), and cognitive status (defined by previously documented dementia, or a mini mental status examination [MMSE] score of 20 to 24 [mild], 11 to 19 [moderate] and <10 [severe dementia]).

Statistical Analysis

Fisher exact or chi-square test was used for categorical variables and Student's *t* test or 1-way analysis of variance (ANOVA) test was used for continuous variables. General linear model univariate analyses were used to examine the degree of association between total analgesic usage against fracture type, surgical procedure, and cognitive status. A *P* value less than .05 was considered statistically significant. SPSS for Windows version 15.0 (SPSS Inc, Chicago, Illinois) was used for data analyses.

Results

Baseline Characteristics

A total of 415 patients presented to the 4 hospitals over the study periods with a diagnosis of hip fracture requiring hip fracture surgery. The participants' ages ranged from 60 to 100 years, with a mean of 81.2 $\pm$ 9.1 years, 74.3% were women, and 274 (66.0%) lived at home prior to admission; 176 (42.4%) were independent with mobility without an aid and 251 (60.5%) were independent with their personal ADL. In all, 195 (47.0%) patients had an SC fracture (39 undisplaced, 156 displaced) while 220 (53.0%) had a trochanteric fracture (42 basicervical, 94 simple pertrochanteric, 60 complex pertrochanteric, 23 subtrochanteric). One-hundred-and-fifty-four (37.6%) had evidence of dementia. Thirty-seven (8.9%) had a previous hip fracture and 158 (38.1%) had previously documented osteoporosis or an atraumatic fracture. One hospital (BLH) had 202 (48.7%) patients, while the other 3 had approximately equal numbers. Despite this, a baseline analysis for age, gender, premorbid place of residence, and dementia status showed that participants from the 4 hospitals had similar baseline characteristics (Table 1).

Table 1. Baseline Characteristics of the 415 Study Participants[a]

Variable	Number (%)
Age (SD)	81.2 (9.1)
English-speaking background	299 (72.0)
Residence	
Own home, alone	112 (27.0)
Own home, with others	162 (39.0)
Community group home	11 (2.7)
Residential aged care (low)	37 (8.9)
Residential aged care (high)	93 (22.4)
Prior mobility status[b]	
Full community	159 (42.5)
Limited community	95 (25.4)
Full mobility indoors	33 (8.8)
Limited mobility indoors	70 (18.7)
Mobility for transfers only	14 (3.7)
Immobile/bed bound	3 (0.8)
Prior functional activities of daily living (ADLs)	
Mean (median, SD)	3.77 (5, 1.79)
Dementia status[b]	
Normal cognition	255 (62.3)
Mild	54 (13.2)
Moderate	48 (11.7)
Severe	52 (12.7)

[a] All data are expressed in numbers (% of total) except for continuous variables.
[b] Missing values, excluded from percentage count.

Participants with trochanteric fractures were significantly more likely to have cognitive impairment compared with those without (56.1% vs 42.9%, $P = .025$). There were no other significant imbalances among the different hip fracture subtypes in terms of age, premorbid place of residence, prior mobility, and ADL status. In addition, similar baseline analyses for surgical procedures and institutions did not show any significant baseline imbalances.

Hip Fracture Subtype

There was a clear significant difference in analgesia use in the 36 hours following various operations for a hip fracture, with subtrochanteric fractures requiring more analgesia (oral morphine equivalent) compared with displaced SC, undisplaced SC, basicervical, stable pertrochanteric, and unstable pertrochanteric fractures (50.5 vs 39.6 vs 24.3 vs 30.0 vs 19.3 vs 22.2 mg, $P = .006$). There were similar differences in the time periods 12 to 24 and 24 to 36 hours following surgery (Table 2).

Surgical Procedure

Total analgesia requirements were higher in patients treated with an intramedullary nail compared with other modalities, increasing by 1.6- to 2.9-fold between 12 and 24 hours ($P < .001$), 2- to 3.3-fold between 24 and 36 hours ($P < .001$), and 1.3- to 2.6-fold during the first 36 hours postsurgery ($P < .001$; Table 3).

Cognitive Status

Patients with cognitive impairment utilized markedly less analgesia at all time periods after hip fracture surgery than cognitively intact patients: 0 to 6 hours (5.1 vs 3.3 mg oral morphine equivalent, $P = .037$), 6 to 12 hours (5.8 vs 4.1 mg, $P = .023$), 12 to 24 hours (8.9 vs 5.2 mg, $P < .001$), 24 to 36 hours (12.8 vs 7.2 mg, $P = .001$), and 0 to 36 hours (32.5 vs 19.6 mg, $P < .001$). For cognitively intact patients, analgesia requirements (36 hours) were highest for patients treated with an intramedullary nail (64.0 mg) and significantly less for uncemented and cemented hemiarthroplasty (17.4 mg and 20.1 mg, respectively), $P = .001$. For patients with dementia (n = 154), there were no statistically significant differences in analgesia requirements according to surgical procedure or hip fracture subtype for dementia severity subgroups (mild, moderate, severe).

Premorbid Mobility and ADL Status

Participants who had full community ambulation prior to their hip fractures had higher analgesia requirements compared to those who were immobile or bed-bound at 24 to 36 hours (9.3 vs 3.3 mg, $P = .015$), with a similar trend over the period of 36 hours (26.8 vs 12.3 mg, $P = .083$). There was a trend for participants who were independent without an aid prefracture requiring significantly higher amounts of analgesia compared to those who were immobile (27.1 vs 8.6 mg, $P = .37$). A similar trend existed for participants who had a higher level of ADL function (5/5) compared to those with lower levels of function (0/5; 29.9 vs 14.0 mg, $P = .073$). Analgesia requirements were significantly lower in participants with lower levels of function (0/5) with higher values in those with higher levels of function (4/5, 5/5) upon discharge from hospital at 24 to 36 hours (5.4 vs 8.7 and 15.3 mg, $P = .007$) and throughout the entire 36 hours postsurgery (14.4 vs 25.8 and 38.4 mg, $P = .003$).

Discussion

This study has shown important differences in utilization of analgesia following hip fracture across readily defined clinical groups. It is the first large-scale prospective study conducted over multiple sites in Australia and is of a larger size compared with Foss et al[19] to have the power to detect differences in analgesic requirements. Our sample covers patients treated by multiple surgeons from 4 orthopedic departments as well as treatment by multiple anesthetists, reflecting real-world orthopedic surgical and anesthetic management. It is also likely that a similar regimen for postoperative nursing and medical care is applied in the postoperative setting and as such minimized confounding factors. Finally, it is an all-inclusive study, including those who would ordinarily have been excluded, such as people with dementia and those living in residential aged care facilities.

Our study validates previous findings[10,11] that unstable pertrochanteric fractures require more analgesia than stable pertrochanteric fractures and that undisplaced SC fractures

Table 2. Analgesia Requirements Following Hip Fracture Surgery According to Hip Fracture Subtypes in 415 Patients

Postop Analgesia Usage (mg[a])	Subcapital Undisplaced Fracture (n = 39)	Subcapital Displaced Fracture (n = 156)	Basicervical Fracture (n = 42)	Simple Interchanteric Fracture (n = 94)	Complex Interchanteric Fracture (n = 60)	Subtrochanteric Fracture (n = 24)	P Value[b]
0-6 hours	8.3 (24.3)	4.5 (6.3)	4.9 (6.5)	2.3 (5.1)	2.2 (5.7)	4.4 (7.4)	.034
6-12 hours	10.3 (24.8)	4.4 (7.8)	5.4 (6.6)	4.3 (5.2)	3.2 (5.3)	6.3 (8.18)	.02
12-24 hours	8.8 (18.1)	6.6 (10.1)	7.6 (9.2)	5.2 (5.5)	7.3 (8.7)	15.0 (20.2)	.027
24-36 hours	11.3 (17.1)	8.8 (18.1)	12.1 (17.4)	7.6 (5.9)	9.7 (15.8)	24.7 (27.2)	.001
0-36 hours	39.6 (77.6)	24.3 (35.6)	30.0 (32.3)	19.3 (14.7)	22.2 (26.0)	50.5 (39.7)	.006

[a] Denotes mean equivalent of oral morphine in milligrams (standard deviation).
[b] Continuous variables were compared with the use of a Student *t* test.

Table 3. Analgesia Requirements Following Hip Fracture Surgery According to Orthopedic Procedure in 415 Patients

Postop Analgesia Usage (mg[a])	Cannulated Screw (n = 36)	Uncemented Hemi-arthroplasty (n = 76)	Cemented Hemi-arthroplasty (n = 48)	Total Hip Replacement (n = 28)	Sliding Hip Screw With Short Plate (n = 160)	Sliding Hip Screw With Long Plate (n = 43)	Gamma Nail (n = 24)	P Value[b]
0-6 hours	6.0 (7.5)	3.2 (5.6)	5.3 (7.0)	9.8 (28.0)	2.7 (5.5)	5.0 (7.4)	7.6 (6.4)	.003
6-12 hours	8.0 (10.6)	3.3 (7.4)	2.6 (5.5)	11.4 (27.7)	4.5 (6.1)	5.2 (8.1)	9.1 (7.7)	.001
12-24 hours	12.9 (17.5)	4.9 (6.8)	5.8 (8.3)	11.5 (28.2)	5.9 (6.6)	9.6 (13.8)	12.8 (15.9)	.001
24-36 hours	24.6 (33.0)	4.4 (6.3)	5.8 (8.0)	7.0 (9.1)	8.9 (11.9)	14.9 (18.0)	26.9 (32.0)	<.001
0-36 hours	51.5 (61.2)	15.8 (21.6)	19.4 (20.6)	39.5 (83.8)	21.7 (23.4)	34.7 (36.9)	56.4 (54.0)	<.001

[a] Denotes mean equivalent of oral morphine in milligrams (standard deviation).
[b] Continuous variables were compared with the use of analysis of variance (ANOVA).

require more analgesia than displaced SC fractures in patients with hip fractures at 24 to 36 hours. This is consistent with the theory that the instability of the hip fracture (both the type of hip fracture, SC or trochanteric, and the number of fracture fragments) is a strong determinant for the amount of pain relief required. The result of higher analgesia requirements for participants with undisplaced SC compared with pertrochanteric fractures is contrary to previous findings which found lower total analgesic usage in the former group in the original study.[10] This may be explained by a greater proportion of patients with cognitive impairment in the pertrochanteric fractures group, and the labelling of patients with subtrochanteric fractures in the ''unstable pertrochanteric'' fractures group in the original research.[10] The unstable types of fractures, including subtrochanteric and multiple-part intertrochanteric are often injuries of higher intensity and often require intramedullary nails, leading to an overall higher area of injury. This may explain the link between unstable fractures with higher analgesic requirements.

Further, patients undergoing an intramedullary nail required significantly higher levels of analgesia compared with other procedures. This is somewhat consistent with data from Mak et al[10] and Foss et al[19] who reported that the highest dynamic pain levels following hip fracture occurred with both hip flexion and walking for those treated with dynamic hip screws or intramedullary nails compared with arthroplasty or parallel screws. However, our results suggest that instrumentation with intramedullary nails, in particular, required significantly greater amounts of analgesia (severalfold), compared with dynamic hip screw and the other procedures. This is an expected result given the greater extent of instrumentation of the femur. Arthroplasty has a large incision and amount of tissue trauma but removes the fracture site; the dynamic hip screw has a moderate level of tissue trauma; and intramedullary nails have significantly higher bone trauma while leaving the fractured bone fragments in situ.[20]

We also found that patients with cognitive impairment received lower amounts of analgesia following a hip fracture. This may be due to intrinsic (patients with dementia probably have less ability to request analgesia) and extrinsic reasons (incorrect nursing concerns about opioids exacerbating or contributing to delirium limiting adequate analgesia provision). In fact, in patients with intact cognition, undertreatment for pain is associated with a 9-fold risk of delirium.[12] In addition, a recent study[21] showed an association between a low dose of analgesia and development of delirium for patients who were in pain (mean percentage of analgesia: 48.2% vs 26.1% with delirium, $P < .001$). A further explanation for undertreatment is the theory that those with cognitive impairment may have altered pain perception.[22] However, this view is generally not supported by the literature.[23] Indeed, recent guidelines recommend that analgesia be reviewed before, during, and after hip fracture surgery.[24]

Several studies have linked hip fracture subtype with short-term function. Cornwall et al[25] found that patients with nondisplaced SC fractures had higher overall locomotor, transfer, and self-care functional ability scores than did patients with unstable trochanteric fractures. At 6 months, fracture type was not an independent predictor of outcome; only preinjury overall functional ability was a strong independent predictor of 6-month overall, locomotor, transfer, and self-care FIM scores in multivariate analyses.

Both preoperative and postoperative pain associated with hip fractures has been predictive of posthospitalization function. In our cohort of 415 patients, we found that participants with higher levels of mobility and ADL function prefracture required significantly higher levels of analgesia compared with those with lower premorbid levels. Our observation of lower amounts of analgesia usage in participants who were bedbound and mobile is consistent with increased dynamic pain on mobility and in any movement associated with ADL function. Foss et al,[19] in a smaller prospective cohort, found an inverse relationship between ambulatory capacity and dynamic pain levels, consistent with our results. Arinzon et al[26] found that with every increase of 1 point in the visual analogue scale (VAS) on admission above 4 points, functioning as assessed by the Functional Independence Measure on discharge decreased by 8.77 and the length of stay increased by 4.76 days. Dasch et al[27] found that surgical procedure was found to be predictive of posthospitalization fracture–related pain. Further, postoperative pain is one of the strongest independent risk factors for incident depression and the latter was associated with a less favorable outcome at 3 months follow-up, which is again related to the level of pain.[28] Pain intensity is strongly negatively associated with both domestic and social functioning. Increases in pain intensity between 6 and 12 months were also associated with concurrent decreases in function, suggesting that pain relief must be adequately treated and maintained to sustain recovery.[29]

Our study has several limitations. First, analgesia use as an outcome measure is a surrogate marker for pain and we did not measure any subjective reports of pain such as the VAS or verbal descriptive scale (VDS). Differences in analgesia consumption may imply differences in pain control (which were not tested) or differences in inherent patient characteristics (eg, pain tolerance or cognitive status). Such assessments, however, may not have been appropriate for our patients with cognitive impairment, and an observer-rated pain scale such as the FLACC[30] may have been used to more accurately document this. Second, we used a single MMSE score, or a recorded history of dementia, as a surrogate marker of cognitive status. Patients with delirium with intact cognition may have been identified as cognitively impaired, but it is known that people with cognitive impairment are at risk of delirium and so both conditions usually coexist.[31] Conversely, inadequate treatment of pain may have contributed to delirium, which has not been and could not be adequately assessed within the constraints of our study. The effect of gender on analgesia was not studied. However, in previous studies, pain levels have not been gender-dependent in elderly patients[32] and would not have been expected to differ in our cohort. Finally, there is an assumption of standard surgical techniques being used across all surgeons at the 4 hospitals for both privately insured and patients treated in a public health care program included in the study. Postoperative pain levels may be related to and vary depending on the surgical approaches, technique, and competency from the surgeons. There may also be important variations that depend on the quality of the medical care (co-management), timing of surgery, nursing care/expertise, local care (ice, positioning), and physical therapy that have not been accounted. Future studies will focus on the benefits of a protocol-based approach according clinical risk factors for hip fractures including fracture subtype, surgical procedure, and cognitive status on postoperative hip pain, functional mobility, and ADL status.

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