Predictors of Long-Term Pain After Hip Arthroplasty in Patients With Femoral Neck Fractures: A Cohort Study

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Objectives: To identify factors associated with the development of prolonged pain after hip fracture surgery.

Design: Secondary analysis of a randomized controlled trial.

Setting: Eighty hospitals in 10 countries.

Patients/Participants: One thousand four hundred forty-one hip fracture patients in the HEALTH trial.

Interventions: Total hip arthroplasty or hemiarthroplasty.

Main Outcome Measures: Moderate-to-severe pain (at least 2 activities on the Western Ontario and McMaster Universities Osteoarthritis questionnaire pain subscale with scores ≥2) at 12 and 24 months after hip arthroplasty.

Results: Of 840 and 726 patients with complete baseline data and outcomes at 1-year and 2-year follow-up, 96 (11.4%) and 80 (11.0%) reported moderate-to-severe pain, respectively. An increased risk of pain at both 1 and 2 years after surgery was associated with reporting moderate-to-severe hip pain before fracture [absolute risk increase (ARI) 15.3%, 95% confidence interval (CI) 6.44%–24.35%; ARI 12.5%, 95% CI 2.85%–22.12%, respectively] and prefracture opioid use (ARI 15.6%, 95% CI 5.41%–25.89%; ARI 21.1%; 95% CI 8.23%–34.02%, respectively). Female sex was associated with an increased risk of persistent pain at 1 year (ARI 6.2%, 95% CI 3.53%–8.84%). A greater risk of persistent pain at 2 years was associated with younger age (<79-year-old; ARI 6.3%; 95% CI 2.67%–9.91%) and higher prefracture functional status (ARI 10.7%; 95% CI 3.80%–17.64%).

Conclusions: Among hip fracture patients undergoing arthroplasty, approximately one in 10 will experience moderate-to-severe pain up to 2 years after surgery. Younger age, female sex, higher functioning prefracture, living with hip pain prefracture, and use of prescription opioids were predictive of persistent pain.

Key Words: hip arthroplasty, hemiarthroplasty, femoral neck fracture, predictors, pain
Level of Evidence: Prognostic Level II. See Instructions for Authors for a complete description of levels of evidence.

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INTRODUCTION

Hip fracture is a severe and frequent event affecting a large number of older adults around the world. Approximately 52,000 hip fracture–related hospital admissions were reported among the population aged 80 years and older between 2011 and 2015 in Ontario, Canada, alone. Hip fractures are associated with impaired mobility, loss of quality of life, and one-year mortality rate estimations between 14% and 58% after injury.

Displaced femoral neck fractures are common injuries, which are often managed with arthroplasty, especially for patients ≥80 years. With an aging population globally, the demands for arthroplasty are predicted to increase substantially. Although symptom relief is an important goal of hip arthroplasty, many patients experience persistent postsurgical pain. For instance, one study of patients with a displaced subcapital hip fracture found that 13% reported moderate-to-severe persistent pain at one year after the surgery. Some evidence suggests that total hip arthroplasty (THA) may provide better long-term pain relief than hemiarthroplasty; however, the HEALTH randomized controlled trial results did not find a benefit of THA over hemiarthroplasty in reducing persistent pain. Improved understanding of factors associated with long-term pain after hip arthroplasty could facilitate targeting of high-risk patients in an effort to improve prognosis.

In this study, we aimed to investigate which factors (modifiable and nonmodifiable) are associated with moderate-to-severe pain at 12 and 24 months after hip arthroplasty in participants aged 50 years and older with a displaced femoral neck fracture.

MATERIAL AND METHODS

Participants

This study used data from 1441 participants enrolled in the HEALTH trial, a randomized controlled trial that explored the effect of THA or hemiarthroplasty for patients ≥50 years with a displaced femoral neck fracture.

Outcome Measure

In the HEALTH trial, the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) questionnaire was administered to assess hip-related pain status of patients before their fracture occurred (completed at time of study enrollment) and at 12 months and 24 months after surgery. The WOMAC has been shown to be valid, reliable, responsive, and feasible in hip fracture patients. The questionnaire contains 5 different activity questions for pain intensity assessment with options of “no,” “mild,” “moderate,” “severe,” and “extreme” pain. We summed these scores for all 5 questions and calculated the overall pain score (range 0–20) for each patient. In keeping with previous studies, we defined our outcome as the presence of moderate-to-severe pain (a score of 2 or more for at least 2 questions on activities using the WOMAC pain subscale) or no moderate-to-severe pain (a score of 0 or 1 for at least 3 items on activities, which we used as the reference group in our analysis) at 12 and 24 months after hip surgery.

Predictors

The first group of predictors consisted of demographic variables, including age (≤79 vs. >79 years). We also considered prefracture variables including those reporting moderate-to-severe hip pain before the occurrence of the fracture (yes vs. no), use of opioid medications before fracture (yes vs. no), prefracture functional status (ambulating without assistance vs. use of an assistive device), prefracture living status (institutionalized vs. noninstitutionalized), previous surgery affecting hip (yes vs. no), having major comorbidities including back pain, osteoarthritis, cancer, rheumatoid arthritis, and depression (yes vs. no), body mass index (BMI, 25–34.9 kg/m² vs. ≥24.9 kg/m²), and the American Society of Anesthesiologists (ASA) classification (III/IV/V vs. I/II). In addition, procedure-related factors, including type of arthroplasty surgery (THA vs. bipolar or unipolar hemiarthroplasty) and type of surgical approach (anterolateral/direct anterior vs. posterior/posterolateral), were included. We also considered 4 postoperative variables, all of which were measured up to 30 days after surgery, including patient’s weight-bearing status (non/partial vs. full), use of any physiotherapy or rehabilitation (yes vs. no), serious adverse events (yes vs. no), and fracture-related complications (complication with or without revision surgery vs. no complication). We chose 30 days after surgery as our cut-off mark to avoid concerns regarding the temporality of the predictors and the study outcomes.

Statistical Analysis

We reported the mean and SD of continuous variables, and absolute and relative frequencies for categorical variables. We used logistic regression analyses to determine predictors of moderate-to-severe pain at 12 and 24 months after hip fracture repair. We excluded patients from our analyses if their pain score, measured using the WOMAC, before fracture and at follow-up times (12 and 24 months), were unavailable. We first ran univariable models to estimate the unadjusted odds ratios (ORs), then we constructed multivariable models for both visits. We selected 12 independent factors for multivariable models previously reported as important predictors or variables judged to be associated with persistent pain by experts, including age, sex, BMI, prefracture moderate-to-severe hip pain, opioid use, functional status, depression, weight-bearing status, use of any physiotherapy or rehabilitation, and serious adverse events. We also adjusted for the type of arthroplasty surgery and surgical approach that were used in the HEALTH trial. We excluded independent variables with fewer than 50 observations per category, unless we were able to collapse them with other related variables to exceed this threshold (Table 1). We then applied the Hosmer–Lemeshow (H-L) goodness of fit test for these adjusted models and reported the statistics.
### TABLE 1. Demographics and Clinical Characteristics at 12- and 24-Month Follow-up Visits in Patients With Femoral Neck Fractures

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>12 months</th>
<th>24 months</th>
<th>12 months</th>
<th>24 months</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic factors</strong></td>
<td></td>
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<tr>
<td>Age, n (%) Below median (≤79 years)</td>
<td>399 (47.5)</td>
<td>346 (86.7)</td>
<td>53 (13.3)</td>
<td>362 (49.9)</td>
</tr>
<tr>
<td></td>
<td>441 (52.5)</td>
<td>398 (90.2)</td>
<td>43 (9.8)</td>
<td>364 (50.1)</td>
</tr>
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<td></td>
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</tr>
<tr>
<td>Sex, n (%) Female</td>
<td>618 (73.6)</td>
<td>538 (87.0)</td>
<td>80 (13.0)</td>
<td>546 (75.0)</td>
</tr>
<tr>
<td></td>
<td>222 (26.4)</td>
<td>206 (92.8)</td>
<td>16 (7.2)</td>
<td>180 (25.0)</td>
</tr>
<tr>
<td><strong>Preoperative factors</strong></td>
<td></td>
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<tr>
<td>BMI, n (%) ≤24.9</td>
<td>431 (52.0)</td>
<td>384 (89.1)</td>
<td>47 (10.9)</td>
<td>368 (51.0)</td>
</tr>
<tr>
<td></td>
<td>399 (48.0)</td>
<td>352 (88.2)</td>
<td>47 (11.8)</td>
<td>351 (49.0)</td>
</tr>
<tr>
<td>Prefracture moderate-to-severe hip pain, n (%)* No</td>
<td>696 (89.7)</td>
<td>631 (90.7)</td>
<td>65 (9.3)</td>
<td>605 (90.7)</td>
</tr>
<tr>
<td></td>
<td>80 (10.3)</td>
<td>60 (75.0)</td>
<td>20 (25.0)</td>
<td>62 (9.3)</td>
</tr>
<tr>
<td>Prefracture opioid use, n (%) No</td>
<td>774 (92.1)</td>
<td>695 (89.8)</td>
<td>79 (10.2)</td>
<td>670 (92.2)</td>
</tr>
<tr>
<td></td>
<td>66 (7.9)</td>
<td>49 (74.2)</td>
<td>17 (25.8)</td>
<td>56 (7.7)</td>
</tr>
<tr>
<td>Prefracture functional status, n (%)† Uses an assistive device</td>
<td>673 (80.1)</td>
<td>603 (89.6)</td>
<td>70 (10.4)</td>
<td>589 (81.1)</td>
</tr>
<tr>
<td></td>
<td>167 (19.9)</td>
<td>141 (84.4)</td>
<td>26 (15.6)</td>
<td>137 (18.8)</td>
</tr>
<tr>
<td>Ambulate without assistance</td>
<td>822 (97.9)</td>
<td>731 (89.0)</td>
<td>91 (11.0)</td>
<td>717 (98.7)</td>
</tr>
<tr>
<td>Institutionalized</td>
<td>18 (2.1)</td>
<td>13 (72.2)</td>
<td>5 (27.8)</td>
<td>9 (1.2)</td>
</tr>
<tr>
<td>Previous surgery to affected hip n (%)‡ No</td>
<td>836 (99.6)</td>
<td>740 (88.5)</td>
<td>96 (11.5)</td>
<td>723 (99.7)</td>
</tr>
<tr>
<td></td>
<td>3 (0.4)</td>
<td>3 (100)</td>
<td>0 (0)</td>
<td>2 (0.28)</td>
</tr>
<tr>
<td>ASA class, n (%) I/II</td>
<td>416 (49.5)</td>
<td>370 (89.0)</td>
<td>46 (11.0)</td>
<td>389 (53.5)</td>
</tr>
<tr>
<td></td>
<td>424 (50.4)</td>
<td>374 (88.2)</td>
<td>50 (11.8)</td>
<td>337 (46.4)</td>
</tr>
<tr>
<td>III/IV/V</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Preoperative comorbidities</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rheumatoid arthritis, n (%) No</td>
<td>817 (97.3)</td>
<td>725 (88.8)</td>
<td>92 (11.2)</td>
<td>704 (96.9)</td>
</tr>
<tr>
<td></td>
<td>23 (2.7)</td>
<td>19 (82.6)</td>
<td>4 (17.4)</td>
<td>22 (3.0)</td>
</tr>
<tr>
<td>Osteoarthritis, n (%) No</td>
<td>714 (85)</td>
<td>643 (90.0)</td>
<td>71 (10.0)</td>
<td>623 (85.8)</td>
</tr>
<tr>
<td></td>
<td>126 (15)</td>
<td>101 (80.1)</td>
<td>25 (19.9)</td>
<td>103 (14.1)</td>
</tr>
<tr>
<td>Cancer, n (%) No</td>
<td>757 (90.1)</td>
<td>674 (89.0)</td>
<td>83 (11.0)</td>
<td>654 (90.0)</td>
</tr>
<tr>
<td></td>
<td>83 (9.9)</td>
<td>70 (84.3)</td>
<td>13 (15.7)</td>
<td>72 (9.9)</td>
</tr>
</tbody>
</table>

(continued on next page)
We assessed the impact of influential observations by calculating the deviance residual and explored for multicollinearity among the independent variables using the variance inflation factor, with values greater than 5 indicating a possible issue regarding collinearity. Discriminability of the models was checked using the area under the curve statistic, with values between 0.7 and 0.8 indicating acceptable classification performance of a model. We reported adjusted ORs (aORs) along with their 95% confidence intervals (95% CIs). In addition, we reported the absolute risk increase (ARI) for each significant predictor in the selected adjusted models by estimating the baseline risk of outcome

### TABLE 1. (Continued) Demographics and Clinical Characteristics at 12- and 24-Month Follow-up Visits in Patients With Femoral Neck Fractures

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>12 months</th>
<th>24 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total, n = 840</td>
<td>No Moderate-to-Severe Pain, n = 744</td>
</tr>
<tr>
<td>Depression, n (%)</td>
<td>738 (87.9)</td>
<td>658 (89.1)</td>
</tr>
<tr>
<td>No</td>
<td>102 (12.1)</td>
<td>86 (84.0)</td>
</tr>
<tr>
<td>Yes</td>
<td>759 (90.3)</td>
<td>679 (89.4)</td>
</tr>
<tr>
<td>Back pain, n (%)</td>
<td>81 (9.7)</td>
<td>65 (80.2)</td>
</tr>
<tr>
<td>Procedure-related factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical approach, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior/posterolateral</td>
<td>315 (37.5)</td>
<td>284 (90.1)</td>
</tr>
<tr>
<td>Anterolateral/direct anterior</td>
<td>524 (62.46)</td>
<td>459 (87.6)</td>
</tr>
<tr>
<td>Surgery type, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THA</td>
<td>414 (49.4)</td>
<td>372 (89.9)</td>
</tr>
<tr>
<td>Bipolar hemiarthroplasty</td>
<td>212 (25.3)</td>
<td>186 (87.8)</td>
</tr>
<tr>
<td>Unipolar hemiarthroplasty</td>
<td>212 (25.3)</td>
<td>184 (86.8)</td>
</tr>
<tr>
<td>Postoperative factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early weight-bearing status, n (%)†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non or partial</td>
<td>355 (42.2)</td>
<td>317 (89.3)</td>
</tr>
<tr>
<td>Full</td>
<td>485 (57.8)</td>
<td>427 (88.0)</td>
</tr>
<tr>
<td>Early physiotherapy or rehabilitation, n (%)‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>61 (7.3)</td>
<td>51 (83.6)</td>
</tr>
<tr>
<td>Yes</td>
<td>774 (92.7)</td>
<td>690 (89.1)</td>
</tr>
<tr>
<td>Serious adverse events, n (%)§</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>672 (80.0)</td>
<td>596 (88.7)</td>
</tr>
<tr>
<td>Yes</td>
<td>168 (20.0)</td>
<td>148 (88.1)</td>
</tr>
<tr>
<td>Fracture-related complications, n (%)‡§</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No complication</td>
<td>774 (92.2)</td>
<td>686 (88.6)</td>
</tr>
<tr>
<td>Complication without revision surgery</td>
<td>29 (3.4)</td>
<td>27 (93.1)</td>
</tr>
<tr>
<td>Complication with revision surgery</td>
<td>37 (4.4)</td>
<td>31 (83.8)</td>
</tr>
</tbody>
</table>

*The WOMAC questionnaire was administered and asked patients to indicate the severity of hip pain before their fracture occurred.† Variables with very low frequency in one subcategory were not included in the regression models.‡ These variables were collected immediately after surgery.§ These variables were collected within 30 days after surgery.ASA, American Society of Anesthesiologists; BMI, body mass index; THA, total hip arthroplasty.
(for both 12- and 24-month follow-up) among patients who did not have any significant risk factors. We also tested for an interaction between opioid use and functional status, hypothesizing that patients who used opioids and used assistive devices to ambulate before fracture may be more likely to experience moderate-to-severe persistent pain. Variables with \( P \) values less than 0.05 in the adjusted models were considered statistically significant. All analyses were performed in Stata version 15.

RESULTS
At 12- and 24-month follow-up visits, 1127 and 1122 patients, respectively, were eligible for our study. At the 1-year follow-up visit, 64 (5.7%) and by 2 years postoperatively, 113 (10%) participants had died. Of the 1063 and 1009 patients who were alive, 840 (20% missing data) and 726 (28% missing data) had follow-up data available for the analysis of pain at 12 and 24 months follow-up, respectively. Details regarding participant flow and the reasons for exclusion are provided in Fig. 1.

Patient Characteristics
At the 12-month follow-up visit, 96 of the 840 patients (11.4%) and at 24 months, 80 of the 726 patients (11.0%) reported moderate-to-severe pain. Patients had a median age of 79 years, most were women (73.0% at 12 months and 75.0% at 24 months), not institutionalized (approximately 98.0% at both visits) before the fracture occurred and did not have a previous surgery affecting the hip (>99.0%). Demographic, preoperative/prefracture factors, comorbidities, procedure related, and postoperative characteristics among patients with and without moderate-to-severe pain are presented in Table 1.

Multivariable Logistic Model at 12-Month Follow-Up Visit
Among 165 patients without identified risk factors for pain (significant predictors in the adjusted model that reduced the risk of moderate-to-severe pain at 12-month visit), 8 reported moderate-to-severe pain at 1 year for a baseline risk of 4.8%. In the adjusted model (Table 2), female patients (OR 1.85; 95% CI 1.0–3.45; ARI 6.2%, 95% CI 3.53%–8.84%):

![Diagram of patient flow](image)
patients with prefracture hip pain (OR 2.68; 95% CI 1.46–4.90; ARI 15.4%, 95% CI 6.44%–24.35%; P = 0.001), and opioid use (OR 2.66; 95% CI 1.35–5.24; ARI 15.7%, 95% CI 5.41%–25.90%; P = 0.005) had a significantly higher risk of experiencing moderate-to-severe pain at 1-year after surgery (Table 2).

**Multivariable Logistic Model at 24-Month Follow-Up Visit**

Among 218 patients without identified risk factors for pain (significant predictors in the adjusted model that reduced the risk of moderate-to-severe pain at 24-months visit), 11 reported moderate-to-severe pain at 2 years for a baseline risk of 5.05%. Patients with prefracture hip pain (OR 2.52; 95% CI 1.25–5.06; ARI 12.5%, 95% CI 2.85%–22.12%; P = 0.01), prefracture opioid use (OR 4.32; 95% CI 2.08–8.95; ARI 21.1%; 95% CI 8.23%–34.02%; P < 0.001), aged ≥79-year-old (OR 1.92; 95% CI 1.09–3.39; ARI 6.3%; 95% CI 2.67%–9.91%; P = 0.025), and who ambulated without assistive devices before surgery (OR 2.38; 95% CI 1.28–4.44; ARI 10.7%; 95% CI 3.80%–17.64%; P = 0.006) were more likely to report moderate-to-severe pain after 2 years (Table 3).

The interaction between prefracture opioid use and functional status was not statistically significant (P = 0.32).

### TABLE 2. Factors Associated With Moderate-to-Severe Pain (vs. Mild or No Pain) at 12 Months in Patients With Femoral Neck Fractures

<table>
<thead>
<tr>
<th>Factor</th>
<th>Unadjusted OR (95% CI)</th>
<th>P</th>
<th>Adjusted OR (95% CI)</th>
<th>P</th>
<th>ARI % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Above median (&gt;79 years)</td>
<td>Reference</td>
<td>0.109</td>
<td>1.42 (0.86–2.32)</td>
<td>0.167</td>
<td></td>
</tr>
<tr>
<td>Below median (≤79 years)</td>
<td>1.41 (0.92–2.17)</td>
<td>0.109</td>
<td>1.42 (0.86–2.32)</td>
<td>0.167</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Reference</td>
<td>0.023</td>
<td>1.85 (1.0–3.45)</td>
<td>0.049</td>
<td>6.2 (3.53–8.84)</td>
</tr>
<tr>
<td>Female</td>
<td>1.91 (1.09–3.35)</td>
<td>0.023</td>
<td>1.85 (1.0–3.45)</td>
<td>0.049</td>
<td>6.2 (3.53–8.84)</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
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<tr>
<td>≤24.9</td>
<td>Reference</td>
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<tr>
<td>25–34.9</td>
<td>1.09 (0.71–1.67)</td>
<td>0.023</td>
<td>0.96 (0.6–1.55)</td>
<td>0.005</td>
<td>15.7 (5.41–25.90)</td>
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<td>Prefracture moderate-to-severe hip pain</td>
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<td></td>
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<tr>
<td>No</td>
<td>Reference</td>
<td>—</td>
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<td></td>
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<tr>
<td>Yes</td>
<td>3.23 (1.83–5.70)</td>
<td>&lt;0.001</td>
<td>2.68 (1.46–4.90)</td>
<td>0.001</td>
<td>15.4 (6.44–24.35)</td>
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<tr>
<td>Prefracture opioid use</td>
<td></td>
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<tr>
<td>No</td>
<td>Reference</td>
<td>—</td>
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<td></td>
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<tr>
<td>Yes</td>
<td>3.05 (1.67–5.55)</td>
<td>&lt;0.001</td>
<td>2.66 (1.35–5.24)</td>
<td>0.005</td>
<td>15.7 (5.41–25.90)</td>
</tr>
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<td>Prefracture functional status</td>
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<tr>
<td>Uses an assistive device</td>
<td>Reference</td>
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<tr>
<td>Ambulate without assistance</td>
<td>1.58 (0.97–2.58)</td>
<td>0.062</td>
<td>1.52 (0.86–2.67)</td>
<td>0.147</td>
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<td>Depression</td>
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<tr>
<td>No</td>
<td>Reference</td>
<td>0.152</td>
<td>1.19 (0.6–2.33)</td>
<td>0.62</td>
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<td>Yes</td>
<td>1.53 (0.85–2.73)</td>
<td>0.152</td>
<td>1.19 (0.6–2.33)</td>
<td>0.62</td>
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<td>Posterior/posterolateral</td>
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<td>0.260</td>
<td>1.1 (0.64–1.89)</td>
<td>0.722</td>
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<td>Anterolateral/direct anterior</td>
<td>1.29 (0.82–2.04)</td>
<td>0.260</td>
<td>1.1 (0.64–1.89)</td>
<td>0.722</td>
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<td>Surgery type</td>
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<td>Bipolar hemiarthroplasty</td>
<td>1.24 (0.74–2.08)</td>
<td>0.421</td>
<td>1.05 (0.59–1.87)</td>
<td>0.858</td>
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<td>Unipolar hemiarthroplasty</td>
<td>1.35 (0.81–2.24)</td>
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<td>1.35 (0.74–2.43)</td>
<td>0.325</td>
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<td>Non or partial</td>
<td>0.88 (0.57–1.36)</td>
<td>0.537</td>
<td>0.94 (0.57–1.57)</td>
<td>0.826</td>
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<td>Yes</td>
<td>0.62 (0.30–1.26)</td>
<td>0.191</td>
<td>0.9 (0.39–2.07)</td>
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<td>Reference</td>
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<td>Yes</td>
<td>1.05 (0.62–1.79)</td>
<td>0.828</td>
<td>0.76 (0.4–1.43)</td>
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Adjusted model: the Hosmer–Lemeshow (HL) test P value: 0.833; C-statistics: 0.67.  
ARI, absolute risk increase; BMI, body mass index; OR, odds ratio; THA, total hip arthroplasty.
We did not find any variables with a variance inflation factor greater than 1.50, and no variables had a deviance residual more than 3, which may suggest no evidence of serious multicollinearity or influential observations in our data.

**DISCUSSION**

We found that approximately one in 10 hip fracture patients experienced moderate-to-severe pain 2 years after arthroplasty. Younger age, female sex, higher functioning before fracture, living with hip pain, and use of prescription opioids were predictive of persistent pain after surgery.

In our adjusted analyses, patients reporting pain and use of opioids before their fracture occurred were more than twice as likely to report persistent moderate-to-severe pain after hip surgery, which is consistent with findings of other studies exploring prognosis after THA and total knee arthroplasty. Evidence suggests that chronic use of opioids may produce opioid-induced hyperalgesia, which can result in pain sensitivity and in developing persistent pain after surgery. In addition, opioids are commonly prescribed for chronic pain; pre-existing pain in another part of the body may influence pain severity of replaced joints. As such, there is a possibility that patients reported persistent pain.

**TABLE 3. Factors Associated With Moderate-to-Severe Pain (vs. Mild or No Pain) at 24 Months in Patients With Femoral Neck Fractures**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Unadjusted OR (95% CI)</th>
<th>P</th>
<th>Adjusted OR (95% CI)</th>
<th>P</th>
<th>ARI % (95% CI)</th>
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<tr>
<td>Age</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Above median (&gt;79 years)</td>
<td>Reference</td>
<td></td>
<td>Reference</td>
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<tr>
<td>Below median (≤79 years)</td>
<td>1.49 (0.93–2.39)</td>
<td>0.093</td>
<td>1.92 (1.09–3.39)</td>
<td>0.025</td>
<td>6.2 (2.67–9.90)</td>
</tr>
<tr>
<td>Sex</td>
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<td>Male</td>
<td>Reference</td>
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<td>Reference</td>
<td></td>
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<tr>
<td>Female</td>
<td>1.15 (0.66–2.00)</td>
<td>0.615</td>
<td>1.20 (0.63–2.28)</td>
<td>0.561</td>
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<tr>
<td>BMI</td>
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<td>≤24.9</td>
<td>Reference</td>
<td></td>
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<tr>
<td>25–34.9</td>
<td>1.29 (0.81–2.06)</td>
<td>0.291</td>
<td>1.09 (0.64–1.86)</td>
<td>0.743</td>
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<td>Prefracture moderate-to-severe hip pain</td>
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<td></td>
<td></td>
<td></td>
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<td>No</td>
<td>Reference</td>
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<tr>
<td>Yes</td>
<td>3.93 (2.11–7.35)</td>
<td>&lt;0.001</td>
<td>2.52 (1.25–5.06)</td>
<td>0.01</td>
<td>12.4 (2.85–22.11)</td>
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<td>Prefracture opioid use</td>
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<td></td>
<td></td>
<td></td>
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<td>No</td>
<td>Reference</td>
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<tr>
<td>Yes</td>
<td>4.20 (2.25–7.85)</td>
<td>&lt;0.001</td>
<td>4.32 (2.08–8.95)</td>
<td>&lt;0.001</td>
<td>21.1 (8.22–34.02)</td>
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<td>Prefracture functional status</td>
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<tr>
<td>Uses an assistive device</td>
<td>Reference</td>
<td></td>
<td>Reference</td>
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<tr>
<td>Ambulate without assistance</td>
<td>2.32 (1.39–3.87)</td>
<td>0.001</td>
<td>2.38 (1.28–4.44)</td>
<td>0.006</td>
<td>10.7 (3.80–17.63)</td>
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<tr>
<td>Depression</td>
<td></td>
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<td>No</td>
<td>Reference</td>
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<tr>
<td>Yes</td>
<td>1.20 (0.61–2.36)</td>
<td>0.606</td>
<td>0.91 (0.41–1.99)</td>
<td>0.807</td>
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<td>Surgical approach</td>
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<td>Posterior/posterolateral</td>
<td>Reference</td>
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<td>Reference</td>
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<td>Anterolateral/direct anterior</td>
<td>0.99 (0.61–1.59)</td>
<td>0.972</td>
<td>0.88 (0.49–1.58)</td>
<td>0.658</td>
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<td>Surgery type</td>
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<td>THA</td>
<td>Reference</td>
<td></td>
<td>Reference</td>
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<tr>
<td>Bipolar hemiarthroplasty</td>
<td>1.58 (0.90–2.75)</td>
<td>0.108</td>
<td>1.42 (0.76–2.66)</td>
<td>0.27</td>
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<td>Unipolar hemiarthroplasty</td>
<td>1.59 (0.89–2.80)</td>
<td>0.112</td>
<td>1.97 (1–3.88)</td>
<td>0.052</td>
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<td>Weight-bearing status</td>
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<td>Full</td>
<td>Reference</td>
<td></td>
<td>Reference</td>
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<tr>
<td>Non or partial</td>
<td>1.29 (0.81–2.06)</td>
<td>0.279</td>
<td>1.50 (0.85–2.64)</td>
<td>0.161</td>
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<tr>
<td>Early physiotherapy or rehabilitation</td>
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<tr>
<td>No</td>
<td>Reference</td>
<td></td>
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<td></td>
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<tr>
<td>Yes</td>
<td>0.57 (0.26–1.21)</td>
<td>0.148</td>
<td>0.79 (0.32–1.96)</td>
<td>0.609</td>
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<tr>
<td>Serious adverse events</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>Reference</td>
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<tr>
<td>Yes</td>
<td>1.14 (0.63–2.04)</td>
<td>0.655</td>
<td>1.06 (0.54–2.08)</td>
<td>0.87</td>
<td></td>
</tr>
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</table>

Adjusted model: the Hosmer-Lemeshow (HL) test P value: 0.229; C-statistics: 0.71.
AR, absolute risk increase; BMI, body mass index; OR, odds ratio; THA, total hip arthroplasty.
moderate-to-severe pain after surgery because of an underlying chronic pain condition. 28

Our results did not indicate that surgery type (eg, THA vs. bipolar or unipolar hemiarthroplasty) is a significant predictor of pain at 1 and 2 years after surgery. We also found no association between receiving early physiotherapy/ rehabilitation or weight-bearing status and pain at 12- and 24-month follow-up. Consistent with our findings, a retrospective study did not find a significant difference between a full versus no weight-bearing status and pain among hip fracture patients who were treated with surgery, 29 although other studies have shown that no-weight-bearing status is related to poor functioning after surgery. 30,31 Our findings also revealed that patients who were able to ambulate without assistive devices experienced more moderate-to-severe pain 2 years after hip arthroplasty. However, these results are in contrast to some studies that reported loss in long-term functional ability was inversely associated with higher prefracture functional status. 32,33 These results suggest that the complex relationship between pain and function after hip fracture surgery requires further evaluation.

Female sex was also associated with persistent hip pain 1 year after surgery. Other researchers have reported similar findings and have stated that female sex is related to increased chronic pain, 34,35 whereas other research has found no association. 36 Younger ages (≤79 vs. >79 years) predicted more moderate-to-severe pain 2 years after hip arthroplasty, which is consistent with previous studies that assessed predictors of chronic pain after surgery. 37,38 Explanations for this result may relate to higher expectations of recovery among younger patients or biological differences, with younger patients probably having greater neuron system responsiveness as compared to older patients. 39 Nevertheless, these findings differ from some studies 40,41 that failed to show age as a significant predictor of persistent pain after surgery.

Our study has some limitations, including a high rate of incomplete data for the outcome, especially at the 2-year follow-up; however, our rate of missing data is consistent with previous studies in this area. 42,43 Baseline characteristics of patients with loss to follow-up data for the outcome were similar to patients with complete data for all significant predictors except for prefracture hip pain and functional status related to the 24-month visit (see Table 1, Supplemental Digital Content 1, http://links.lww.com/JOT/B205). Some relevant comorbidities (eg, anxiety and substance use disorder) or the indication and dose of opioids that patients were using before were not collected in the trial, but for future studies, these variables should be considered. The strengths of our study include using a large, international, representative sample that increases the generalizability of our findings, investigating several clinically relevant independent variables in the prediction model, and using a validated instrument for pain assessment.

CONCLUSION AND FUTURE RECOMMENDATIONS

The results of this study provide insights into those at a higher risk of having moderate-to-severe pain at one and 2 years after hip arthroplasty. Patients with prefracture hip pain, opioid use, independent ambulatory status, female sex, and younger ages (≤79 vs. greater 79 years) are more likely to have long-term moderate-to-severe pain after arthroplasty surgery for management of femoral neck fractures. This information will further inform health care providers and patients and allow for better understanding of the expected benefits of hip arthroplasty in this patient population.

Acknowledgments

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REFERENCES


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