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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

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INTRODUCTION

Hip fracture is a severe and frequent event affecting a large number of older adults around the world.¹ 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.² Hip fractures are associated with impaired mobility, loss of quality of life, and one-year mortality rate estimations between 14% and 58% after injury.^{3–7}

Displaced femoral neck fractures are common injuries, which are often managed with arthroplasty, especially for patients ≥ 80 years.⁸ With an aging population globally, the demands for arthroplasty are predicted to increase substantially.⁹ Although symptom relief is an important goal of hip arthroplasty, many patients experience persistent postsurgical pain.¹⁰ 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.¹¹ Some evidence suggests that total hip arthroplasty (THA) may provide better long-term pain relief than hemiarthroplasty¹²; however, the HEALTH randomized controlled trial results did not find a benefit of THA over hemiarthroplasty in reducing persistent pain.¹³ 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.¹³

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.¹⁴ 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.^{15–17}

Predictors

The first group of predictors consisted of demographic variables, including age (≤ 79 vs. > 79 years, 79 was the median age of all included participants) and sex (women vs. men). 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 predictors¹⁸ 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 models¹⁹ and reported the statistics.

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

Characteristics	12 months			24 months		
	Total, n = 840	No Moderate-to-Severe Pain, n = 744	Moderate-to-Severe Pain, n = 96	Total, n = 726	No Moderate-to-Severe Pain, n = 646	Moderate-to-Severe Pain, n = 80
Demographic factors						
Age, n (%)						
Below median (≤79 years)	399 (47.5)	346 (86.7)	53 (13.3)	362 (49.9)	315 (87.0)	47 (13.0)
Above median (>79 years)	441 (52.5)	398 (90.2)	43 (9.8)	364 (50.1)	331 (91.0)	33 (9.0)
Sex, n (%)						
Female	618 (73.6)	538 (87.0)	80 (13.0)	546 (75.0)	484 (88.6)	62 (11.3)
Male	222 (26.4)	206 (92.8)	16 (7.2)	180 (25.0)	162 (90.0)	18 (10.0)
Preoperative factors						
BMI, n (%)						
≤24.9	431 (52.0)	384 (89.1)	47 (10.9)	368 (51.0)	332 (90.0)	36 (10.0)
25–34.9	399 (48.0)	352 (88.2)	47 (11.8)	351 (49.0)	308 (88.0)	43 (12.0)
Prefracture moderate-to-severe hip pain, n (%)*						
No	696 (89.7)	631 (90.7)	65 (9.3)	605 (90.7)	552 (91.2)	53 (8.8)
Yes	80 (10.3)	60 (75.0)	20 (25.0)	62 (9.3)	45 (72.6)	17 (27.4)
Prefracture opioid use, n (%)						
No	774 (92.1)	695 (89.8)	79 (10.2)	670 (92.2)	607 (90.6)	63 (9.4)
Yes	66 (7.9)	49 (74.2)	17 (25.8)	56 (7.7)	39 (69.6)	17 (30.3)
Prefracture functional status, n (%)						
Uses an assistive device	673 (80.1)	603 (89.6)	70 (10.4)	589 (81.1)	535 (91)	54 (9)
Ambulate without assistance	167 (19.9)	141 (84.4)	26 (15.6)	137 (18.8)	111 (81)	26 (19)
Prefracture living status, n (%)†						
Not institutionalized	822 (97.9)	731 (89.0)	91 (11.0)	717 (98.7)	639 (89.1)	78 (10.8)
Institutionalized	18 (2.1)	13 (72.2)	5 (27.8)	9 (1.2)	7 (77.7)	2 (22.2)
Previous surgery to affected hip n (%)‡						
No	836 (99.6)	740 (88.5)	96 (11.5)	723 (99.7)	644 (89.0)	79 (10.9)
Yes	3 (0.4)	3 (100)	0 (0)	2 (0.28)	1 (50.0)	1 (50.0)
ASA class, n (%)						
I/II	416 (49.5)	370 (89.0)	46 (11.0)	389 (53.5)	354 (91)	35 (9)
III/IV/V	424 (50.4)	374 (88.2)	50 (11.8)	337 (46.4)	292 (87)	45 (13)
Preoperative comorbidities						
Rheumatoid arthritis, n (%)						
No	817 (97.3)	725 (88.8)	92 (11.2)	704 (96.9)	627 (89)	77 (11)
Yes	23 (2.7)	19 (82.6)	4 (17.4)	22 (3.0)	19 (86)	3 (14)
Osteoarthritis, n (%)						
No	714 (85)	643 (90.0)	71 (10.0)	623 (85.8)	556 (90)	67 (10)
Yes	126 (15)	101 (80.1)	25 (19.9)	103 (14.1)	90 (87)	13 (13)
Cancer, n (%)						
No	757 (90.1)	674 (89.0)	83 (11.0)	654 (90.0)	583 (89)	71 (11)
Yes	83 (9.9)	70 (84.3)	13 (15.7)	72 (9.9)	63 (87.5)	9 (12.5)

(continued on next page)

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

Characteristics	12 months			24 months		
	Total, n = 840	No Moderate-to-Severe Pain, n = 744	Moderate-to-Severe Pain, n = 96	Total, n = 726	No Moderate-to-Severe Pain, n = 646	Moderate-to-Severe Pain, n = 80
Depression, n (%)						
No	738 (87.9)	658 (89.1)	80 (10.9)	639 (88.0)	570 (89)	69 (11)
Yes	102 (12.1)	86 (84.0)	16 (16.0)	87 (11.9)	76 (87)	11 (13)
Back pain, n (%)						
No	759 (90.3)	679 (89.4)	80 (10.6)	655 (90.2)	594 (91)	61 (9)
Yes	81 (9.7)	65 (80.2)	16 (19.8)	71 (9.7)	52 (73)	19 (27)
Procedure-related factors						
Surgical approach, n (%)						
Posterior/posterolateral	315 (37.5)	284 (90.1)	31 (9.9)	280 (38.6)	249 (89)	31 (11)
Anterolateral/direct anterior	524 (62.46)	459 (87.6)	65 (12.4)	446 (61.4)	397 (89)	49 (11)
Surgery type, n (%)						
THA	414 (49.4)	372 (89.9)	42 (10.1)	363 (50.0)	331 (91.2)	32 (8.8)
Bipolar hemiarthroplasty	212 (25.3)	186 (87.8)	26 (12.2)	189 (26.0)	164 (86.8)	25 (13.2)
Unipolar hemiarthroplasty	212 (25.3)	184 (86.8)	28 (13.2)	173 (23.8)	150 (86.8)	23 (13.2)
Postoperative factors						
Early weight-bearing status, n (%)‡						
Non or partial	355 (42.2)	317 (89.3)	38 (10.7)	295 (40.7)	258 (87.4)	37 (12.6)
Full	485 (57.8)	427 (88.0)	58 (12.0)	431 (59.3)	388 (90.0)	43 (10.0)
Early physiotherapy or rehabilitation, n (%)‡						
No	61 (7.3)	51 (83.6)	10 (16.4)	53 (7.3)	44 (83.0)	9 (17.0)
Yes	774 (92.7)	690 (89.1)	84 (10.9)	669 (92.7)	599 (89.5)	70 (10.5)
Serious adverse events, n (%)§						
No	672 (80.0)	596 (88.7)	76 (11.3)	594 (81.8)	530 (89.2)	64 (10.8)
Yes	168 (20.0)	148 (88.1)	20 (11.9)	132 (18.2)	116 (87.9)	16 (12.1)
Fracture-related complications, n (%)†§						
No complication	774 (92.2)	686 (88.6)	88 (11.4)	673 (92.7)	600 (89.2)	73 (10.8)
Complication without revision surgery	29 (3.4)	27 (93.1)	2 (6.9)	22 (3.0)	19 (86.4)	3 (13.6)
Complication with revision surgery	37 (4.4)	31 (83.8)	6 (16.2)	31 (4.3)	27 (87.1)	4 (12.9)

*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.

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.²⁰ 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

(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%;

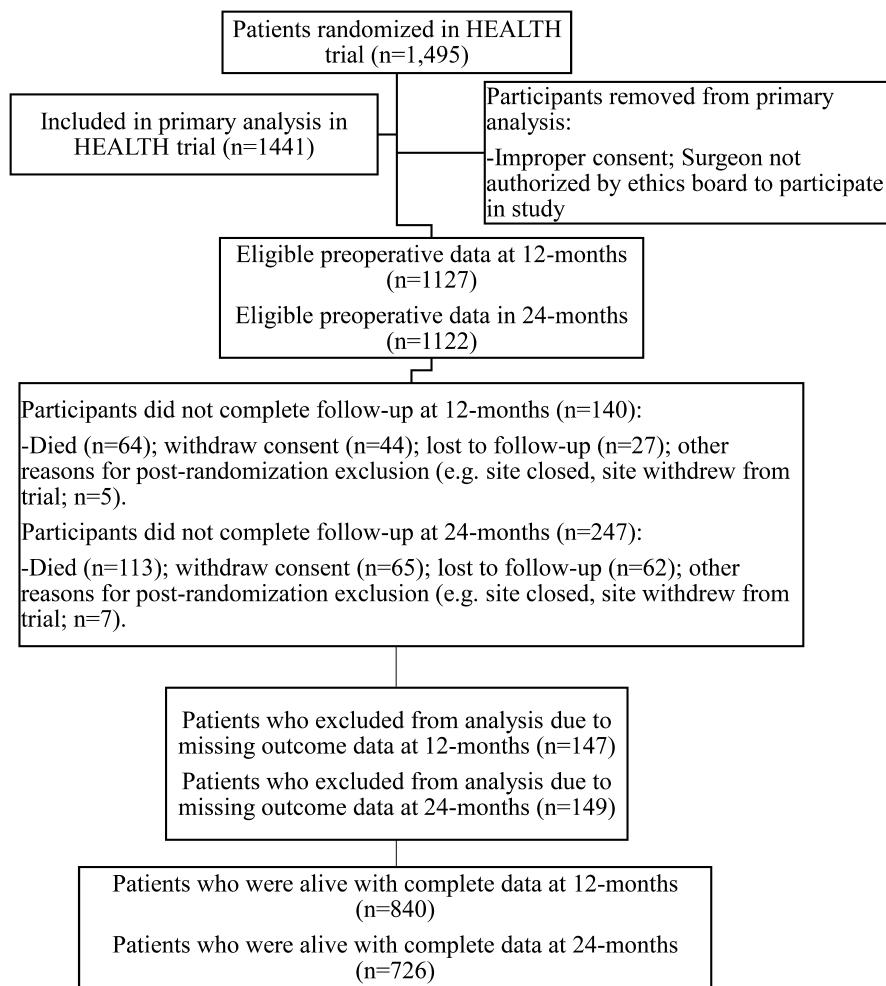


FIGURE 1. Cohort of patients' selection flow.

$P = 0.049$), 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

Factor	Unadjusted OR (95% CI)	P	Adjusted OR (95% CI)	P	ARI % (95% CI)
Age					
Above median (>79 years)	Reference		Reference		
Below median (≤ 79 years)	1.41 (0.92–2.17)	0.109	1.42 (0.86–2.32)	0.167	—
Sex					
Male	Reference		Reference		
Female	1.91 (1.09–3.35)	0.023	1.85 (1.0–3.45)	0.049	6.2 (3.53–8.84)
BMI					
≤ 24.9	Reference	—	Reference		
25–34.9	1.09 (0.71–1.67)	0.691	0.96 (0.6–1.55)	0.874	—
Prefracture moderate-to-severe hip pain					
No	Reference	—	Reference		
Yes	3.23 (1.83–5.70)	<0.001	2.68 (1.46–4.90)	0.001	15.4 (6.44–24.35)
Prefracture opioid use					
No	Reference	—	Reference		
Yes	3.05 (1.67–5.55)	<0.001	2.66 (1.35–5.24)	0.005	15.7 (5.41–25.90)
Prefracture functional status					
Uses an assistive device	Reference	—	Reference		
Ambulate without assistance	1.58 (0.97–2.58)	0.062	1.52 (0.86–2.67)	0.147	—
Depression					
No	Reference	—	Reference		
Yes	1.53 (0.85–2.73)	0.152	1.19 (0.6–2.33)	0.62	—
Surgical approach					
Posterior/posterolateral	Reference	—	Reference		
Anterolateral/direct anterior	1.29 (0.82–2.04)	0.260	1.1 (0.64–1.89)	0.722	—
Surgery type					
THA	Reference	—	Reference		
Bipolar hemiarthroplasty	1.24 (0.74–2.08)	0.421	1.05 (0.59–1.87)	0.858	—
Unipolar hemiarthroplasty	1.35 (0.81–2.24)	0.251	1.35 (0.74–2.43)	0.325	—
Weight-bearing status					
Full	Reference	—	Reference		
Non or partial	0.88 (0.57–1.36)	0.573	0.94 (0.57–1.57)	0.826	—
Early physiotherapy or rehabilitation					
No	Reference	—	Reference		
Yes	0.62 (0.30–1.26)	0.191	0.9 (0.39–2.07)	0.809	—
Serious adverse events					
No	Reference	—	Reference		
Yes	1.05 (0.62–1.79)	0.828	0.76 (0.4–1.43)	0.388	—

Adjusted model: the Hosmer–Lemeshow (HL) test P value: 0.833; C-statistics: 0.67. AR, absolute risk increase; BMI, body mass index; OR, odds ratio; THA, total hip arthroplasty.

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

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

Adjusted model: the Hosmer–Lemeshow (HL) test *P* value: 0.229; C-statistics: 0.71. 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.^{21,22} Evidence suggests that chronic use of opioids may produce opioid-induced hyperalgesia,²³ which can result in pain sensitivity and in developing persistent pain after surgery.^{24,25} 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.^{26,27} As such, there is a possibility that patients reported persistent

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.^{31,32} 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,^{33,34} whereas other research has found no association.³⁵ 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.^{36–38} 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.

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