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Incidence, mortality, and complications of acute myocardial infarction with and without percutaneous coronary intervention in hip fracture patients

Yash P. Chaudhry, Aoife MacMahon, Sandesh S. Rao, Robert S. Sterling, Julius K. Oni, Harpal S. Khanuja*

Department of Orthopaedic Surgery, The Johns Hopkins University School of Medicine, 601 N. Caroline St., Baltimore, MD 21287, USA

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ABSTRACT

Introduction: Acute myocardial infarction (AMI) is a common cause of death following hip fracture surgery. This study aimed to determine the incidence and timing of perioperative AMI treated with percutaneous coronary intervention (PCI) in hip fracture patients, and to compare in-hospital mortality and complications between hip fracture patients who did not have an AMI, those who sustained a perioperative AMI and did not undergo PCI, and those who sustained an AMI and underwent PCI.

Methods: The National Inpatient Sample (NIS) was queried from 2010 through the third quarter of 2015 to identify all patients undergoing hip fracture surgery. Patients were stratified into three cohorts: perioperative AMI but no PCI (no PCI cohort), perioperative AMI with PCI (PCI cohort), and no perioperative AMI or PCI (no AMI cohort). Patient demographics, comorbidities, in-hospital mortality, and complications were compared between cohorts. Multivariable logistic regression adjusting for age, sex, procedure, and Elixhauser score was used to assess the relative odds of in-hospital mortality for each cohort.

Results: A total of 1,535,917 hip fracture cases were identified, with 1.9% in the no PCI cohort, 0.01% in the PCI cohort, and 98.0% in the no AMI cohort. In-hospital mortality was lower in the PCI cohort than in the no PCI cohort (8.8% vs. 14%), and was greater for both than in the no AMI cohort (1.6%, $p < 0.001$ for all). Both the no PCI cohort (OR, 6.1; 95% CI, 5.6–6.6) and PCI cohort (OR, 4.1; 95% CI, 2.8–6.0) had increased adjusted odds of in-hospital mortality compared to the no AMI cohort. The PCI cohort had a higher rate of bleeding complications than both other cohorts, and the no PCI cohort had a higher rate of transfusion than both other cohorts.

Conclusions: Perioperative AMI both with and without PCI independently increases the risk of mortality in hip fracture patients, with the highest risk of mortality in those with AMI without PCI. Providers should understand the increased morbidity and mortality associated with AMI in hip fracture patients, as well as the risks and benefits of perioperative PCI, in order to better counsel and manage these patients.

Level of Evidence: III

Introduction

Hip fractures are common in the elderly population, particularly in those aged over 75 years, and are associated with high rates of morbidity and mortality [1]. Rates of 30-day mortality have been reported to range from 9% to 12%, with estimates of one-year mortality ranging from 27% to 33% [2–5]. Cardiovascular complications including acute myocardial infarction (AMI) are among the most common causes of death following hip fracture surgery [1,4,6], and hip fracture patients who have a perioperative AMI prior to or following hip fracture surgery have increased mortality rates [7,8]. The incidence of perioperative AMI ranges from 6% to 37% [9–14]. However, AMI comprises a heterogenous group of pathologies that includes type 1 AMI, i.e. acute coronary syndrome (ACS), and type 2 AMI, i.e. demand ischemia from underlying coronary artery disease [15]. Each has varying treatment regimens that have significant implications in the perioperative care of hip fracture patients. ACS results when there is an acute ischemic episode due to plaque rupture within the coronary vasculature and is particularly sig-

* Corresponding author.
E-mail address: khanuja@jhmi.edu (H.S. Khanuja).

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nificant because it warrants reperfusion therapy, usually via percutaneous coronary intervention (PCI) to maintain viable cardiac function [16–18]. Patients undergoing PCI are also treated with antiplatelet and anticoagulant adjuvant therapy which may lead to excessive bleeding and transfusions in surgical patients. Nonetheless, the incidence and outcomes of perioperative AMI with PCI in hip fracture patients remains unclear.

Interventions to mitigate the increased morbidity and mortality associated with perioperative AMI in hip fracture and other orthopedic trauma patients have been previously studied. In a single-center retrospective study of hip fracture patients who experienced a perioperative AMI, coronary revascularization was independently associated with improved survival at one year [11]. However, there have been no studies to date investigating the incidence or timing of AMI with subsequent PCI in a U.S. national dataset of hip fracture patients, nor comparing in-hospital mortality and complication rates between hip fracture patients who have had no perioperative AMI, who have had perioperative AMI without PCI, and who have had perioperative AMI with PCI. As there are many contributing factors to perioperative AMI in hip fracture patients [9], understanding the role and timing of such interventions may help to improve the high mortality rates associated with this complication.

The primary aims of this study were to 1) determine the incidence and timing relative to hip fracture surgery of perioperative AMI treated with PCI in hip fracture patients, and 2) to compare in-hospital mortality and complication rates between hip fracture patients without perioperative AMI, those who sustained perioperative AMI without in-hospital PCI, and those with perioperative AMI who underwent in-hospital PCI. We hypothesized that hip fracture patients undergoing perioperative PCI would have lower in-hospital mortality and complication rates than patients with perioperative AMI and no PCI, but higher mortality and complication rates than hip fracture patients with no perioperative AMI. Secondary objectives were to compare mortality rates in hip fracture patients who underwent PCI based on timing of PCI relative to hip fracture surgery and to compare transfusion rates, lengths of stay, hospital costs, and discharge disposition between the three cohorts.

Patients and methods

Patient selection

This was a retrospective cohort study that was considered exempt from approval by our Institutional Review Board. Data was obtained from the National Inpatient Sample (NIS) from January 1st, 2010 to September 30th, 2015. The NIS is an all-payer inpatient healthcare database consisting of a 20% stratified sample of all discharges from U.S. community hospitals, excluding rehabilitation and long-term acute care hospitals. Inclusion criteria were patients who had undergone surgery for a femoral neck fracture, identified by the International Classification of Diseases, Ninth Edition (ICD-9) code 820. Exclusion criteria were age less than 18 years and incomplete medical records. Eligible patients were stratified based on whether they also had perioperative AMI (ICD-9 code 410), and/or PCI (ICD-9 codes 00.66, 17.55, 36.01, 36.02, and 36.05), yielding three cohorts: perioperative AMI without PCI (no PCI cohort), perioperative AMI with PCI (PCI cohort), and no perioperative AMI or PCI (no AMI cohort).

Variables of interest

Variables of interest included age, sex, race/ethnicity, primary payer type, procedure, comorbidities, length of hospital stay, timing of PCI relative to hip fracture surgery, cost of hospitalization, complications, transfusions, mortality, and discharge disposition. Comorbidities assessed included cardiac arrhythmias, coagulopathy, congestive heart failure (CHF), uncomplicated and complicated diabetes, complicated hypertension, peripheral vascular disorders, renal failure, and valvular disease. Complications assessed included acute renal failure, acute heart failure, bleeding complications (including hemorrhage, hematoma, and seroma), cardiac shock, deep vein thrombosis, pulmonary embolism, pneumonia, urinary tract infection, and wound complications. The NIS reports total hospital cost per discharge and cost-to-charge ratio for each hospital. The latter was utilized to obtain the hospitalization cost for each discharge as described by Khorgami et al [19]. Rates of patients undergoing PCI were determined for five time points of the procedure relative to hip fracture surgery: $\geq$ 1 week preoperatively, $<$ 1 week preoperatively, same day, $<$ 1 week postoperatively, and $\geq$ 1 week postoperatively. Mortality rates were calculated for each time period in patients undergoing PCI. The primary outcome of interest was in-hospital mortality. Secondary outcomes were in-hospital complication rates, transfusion rates, hospital costs, lengths of stay, and discharge disposition.

Statistics

Descriptive summaries and national estimates of patient demographic and clinical variables were generated using sampling weights. The Elixhauser comorbidity score, which has been shown to be a valid predictor of 30-day mortality and to be superior to other comorbidity indices in hip fracture patients [20–23], was calculated for each patient based on ICD-9 codes. Variables were compared between the three cohorts. Categorical variables were compared using Chi-squared tests with pairwise comparisons using the Bonferroni correction when significant. Continuous variables were compared with analysis of variance (ANOVA) or Kruskal-Wallis tests, with Tukey's or Dunn's post-hoc tests or when significant, respectively. Multivariable logistic regression adjusting for age, sex, procedure (total hip arthroplasty, hemiarthroplasty, or internal fixation), and Elixhauser score was used to calculate the relative odds of in-hospital mortality with 95% confidence intervals for each cohort. Continuous variables are reported as means and standard deviations and categorical variables are reported as frequencies and percentages. All statistical analyses were performed with Stata, version 15, software (StataCorp, College Station, TX) at a level of significance of alpha = 0.05.

Results

Patient characteristics

A weighted national estimate of 1535,917 hip fracture cases was identified, with 28,670 cases (1.9%) in the no PCI cohort, 1827 cases (0.01%) in the PCI cohort, and 1505,095 cases (98.0%) in the no AMI cohort. Baseline demographic and clinical characteristics of each cohort are shown in Table 1. Patients in the no PCI cohort were older than patients in the PCI and no AMI cohorts, and patients in PCI cohort were older than those in the no AMI cohort ($p <$ 0.001). There was a lower percentage of females in the PCI group in comparison to the no PCI and no AMI groups ($p <$ 0.001). Patients in the no PCI cohort were less likely to be Black or Hispanic in comparison to the PCI and no AMI cohorts, and patients in the no AMI cohort were less likely to be Black or Hispanic than those in the PCI cohort ($p <$ 0.001 for all). Patients in the no PCI cohort were more likely to have Medicare compared to the PCI and no AMI cohorts ($p <$ 0.001). The majority of patients in each cohort were treated with internal fixation, followed by hemiarthroplasty and total hip arthroplasty (THA). However, patients in the no PCI cohort were more likely to be treated with hemiarthroplasty than

Table 1
Demographic and Clinical Characteristics of Hip Fracture Patients by Cohort[1].

Variable	N (%)*				*P*-value
	All Discharges (n = 1535,917)	PCI (n = 1827)	No PCI (n = 28,670)	No AMI (n = 1505,095)	
Patient Characteristics					
Age (years)†	78 ± 13	78 ± 9.4[a,b]	83 ± 8.4[a]	78 ± 14	< 0.001
Female sex‡	1059,651 (69)	1044 (57)[a,b]	18,980 (66)[a]	1039,627 (69)	< 0.001
Race/ethnicity					
White	1234,831 (80)	1444 (79)[b]	23,392 (82)[a]	1209,995 (80)	< 0.001
Black	62,496 (4.1)	92 (4.8)[a,b]	937 (3.3)[a]	61,467 (4.1)	
Hispanic	75,675 (4.9)	108 (5.8)	1060 (3.7)[a]	74,507 (4.9)	
Other/unknown	162,915 (11)	3287 (11)	3287 (11)	159,444 (11)	
Health insurance					
Medicare	1258,690 (82)	1567 (86)[a,b]	25,788 (90)[a]	1231,606 (82)	< 0.001
Medicaid	49,057 (3.2)	46 (2.4)[a,b]	476 (1.7)[a]	48,535 (3.2)	
Private	163,529 (11)	174 (9.5)[a,b]	1905 (6.7)[a]	161,456 (11)	
Other/unknown	64,370 (4.2)	43 (2.3)[a]	491 (1.7)[a]	63,833 (4.2)	
Procedure type					
Internal Fixation	945,603 (62)	1060 (58)	16,066 (56)[a]	928,477 (62)	< 0.001
Hemiarthroplasty	517,189 (34)	694 (38)	11,519 (40)[a]	504,979 (34)	
Total hip arthroplasty	73,140 (4.8)	83 (4.5)	1091 (3.8)[a]	71,958 (4.8)	
Comorbidities					
Total Elixhauser score†	3.2 ± 2.0	4.5 ± 2.0[a]	4.5 ± 2.0[a]	3.2 ± 2.0	< 0.001
Cardiac arrhythmia	457,626 (30)	799 (43)[a,b]	14,269 (50)[a]	442,574 (29)	< 0.001
Coagulopathy	123,442 (8.0)	200 (11)[a]	3302 (12)[a]	119,940 (8.0)	< 0.001
Congestive heart failure	244,887 (16)	722 (40)[a]	13,025 (45)[a]	231,125 (15)	< 0.001
Diabetes					
Uncomplicated	277,571 (18)	476 (26)[a,b]	6052 (21)[a]	271,059 (18)	< 0.001
Complicated	56,015 (3.6)	108 (5.7)[a]	1613 (5.6)[a]	54,295 (3.6)	< 0.001
Hypertension, complicated	242,214 (16)	538 (29)[a]	7910 (28)[a]	233,767 (16)	< 0.001
Peripheral vascular disorder	112,967 (7.4)	276 (15)[a,b]	3671 (13)[a]	109,035 (7.2)	< 0.001
Pulmonary circulation disorder	77,011 (5.0)	184 (10)[a,b]	4086 (14)[a]	72,741 (4.8)	< 0.001
Renal failure	252,428 (16)	538 (29)[a]	8002 (28)[a]	243,888 (16)	< 0.001
Valvular disease	155,235 (10)	369 (20)[a]	6282 (22)[a]	148,569 (10)	< 0.001

[1] AMI, acute myocardial infarction; PCI, percutaneous coronary intervention.
* Percentages and individual cell counts may not sum to total cell counts because of sampling weight application and rounding.
† Reported as mean ± standard deviation.
‡ Of 1535,592 available estimated observations.
[a] Significant difference with no AMI cohort.
[b] Significant difference with no PCI cohort.

the PCI or no AMI cohorts ($p < 0.001$). The Elixhauser score was greater in the PCI and no PCI cohorts than in patients with no AMI ($p < 0.001$). Patients in both the PCI and no PCI cohorts had higher rates of all comorbidities than the no AMI cohort ($p < 0.001$ for all). Moreover, compared to the PCI cohort, the no PCI cohort had higher rates of cardiac arrhythmias, uncomplicated diabetes, peripheral vascular disorders, and pulmonary circulation disorders ($p < 0.001$ for all.)

Postoperative outcomes

Differences in in-hospital mortality and complication rates among the three cohorts are shown in Table 2. The no PCI cohort had the highest in-hospital mortality rate (14%), followed by the PCI cohort (8.8%) and the no AMI cohort (1.6%, $p < 0.001$). In the multivariate logistic regression model, both the no PCI cohort (OR 6.1; 95% CI 5.6–6.6) and PCI cohort (OR 4.1; 95% CI 2.8–6.0) had increased adjusted odds of mortality compared to the no AMI cohort. Of hip fracture patients undergoing PCI, 4.3% underwent the procedure ≥ 1 week preoperatively, 42.2% < 1 week preoperatively, 7.2% on the same day as surgery, 36.2% < 1 week postoperatively, and 10.1% ≥ 1 week postoperatively (Fig. 1). Rates of in-hospital mortality were highest in patients who underwent PCI <1 week or ≥ 1 week postoperatively (14.3% and 11.8% respectively) in comparison to patients who had PCI on the same day as surgery (8.0%), <1 week preoperatively (6.7%), or ≥ 1 week preoperatively (9.1%); however, this was not statistically significant ($p = 0.26$).

There were significant differences among the three cohorts in all complications assessed ($p < 0.001$ for all) (Table 2). Patients in both the no PCI and PCI cohorts had higher rates of acute renal failure and acute heart failure than those with no AMI ($p < 0.001$ for both). Patients in the PCI cohort had a higher rate of bleeding complications than those in the no PCI and no AMI cohorts, and those in the no PCI cohort had a higher rate than those in the no AMI cohort ($p < 0.001$). There were no cases of cardiac shock or wound complications in the PCI cohort, but higher rates in the no PCI than in the no AMI cohort ($p < 0.001$ for both). Patients in the no PCI and PCI cohorts had higher rates of deep vein thrombosis (DVT) and pulmonary embolism (PE) than the no AMI cohort ($p < 0.001$ for both). Moreover, patients in the PCI and no PCI cohorts had higher rates of pneumonia and urinary tract infections than those in the no AMI cohort ($p < 0.001$ for all). There was a higher proportion of patients in the no PCI cohort who underwent transfusion than in the PCI cohort, and both cohorts had higher rates of transfusion than the no AMI cohort ($p < 0.001$).

Differences in hospitalization variables between the three cohorts are shown in Table 3. Patients in the PCI cohort had the longest length of stay (13 ± 9.8 days), followed by the no PCI (10 ± 7.4 days) and no AMI cohorts (5.8 ± 4.6 days; $p < 0.001$). A greater rate of patients in the PCI cohort was discharged to home (10%) compared to the no PCI cohort (6.2%), but at a lower rate than in the no AMI cohort (15%; $p < 0.001$). Patients undergoing PCI had the highest mean hospitalization cost, followed by patients in the no PCI cohort and then by those in the no AMI cohort ($p < 0.001$).

Table 2
In-Hospital Mortality and Complication Rates in Hip Fracture Patients by Cohort[1].

Variable	N (%)*				*P*-value
	All Discharges (n = 1535,917)	PCI (n = 1827)	No PCI (n = 28,670)	No AMI (n = 1505,095)	
In-hospital mortality§	28,880 (1.9)	161 (8.8)[a,b]	3959 (14)[a]	24,768 (1.6)	< 0.001
Acute renal failure	170,287 (11)	568 (31)[a]	9062 (32)[a]	160,657 (11)	< 0.001
Acute heart failure	34,082 (2.2)	276 (15)[a]	4162 (15)[a]	29,628 (2.0)	< 0.001
Bleeding complications	16,496 (1.1)	72 (3.9)[a,b]	691 (2.4)[a]	15,743 (1.0)	< 0.001
Cardiac shock	430 (0.03)	0 (0)	154 (0.5)[a]	276 (0.02)	< 0.001
Deep venous thrombosis	11,965 (0.8)	31 (1.3)[a]	476 (1.6)[a]	11,473 (0.8)	< 0.001
Pulmonary embolism	10,475 (0.7)	35 (1.9)[a]	753 (2.6)[a]	9692 (0.6)	< 0.001
Pneumonia	63,925 (4.2)	215 (12)[a]	3502 (12)[a]	60,208 (4.0)	< 0.001
Transfusion	265,130 (7.4)	219 (25)[a,b]	1376 (35)[a]	263,535 (7.3)	< 0.001
Urinary tract infection	269,308 (18)	461 (25)[a]	6958 (24)[a]	261,905 (17)	< 0.001
Wound complications	1029 (0.07)	0 (0)	34 (0.1)[a]	998 (0.07)	0.28

[1] AMI, acute myocardial infarction; PCI, percutaneous coronary intervention.
* Percentages and individual cell counts may not sum to total cell counts because of sampling weight application and rounding.
§ Of 1534,556 available estimated observations.
[a] Significant difference with no AMI cohort.
[b] Significant difference with no PCI cohort.

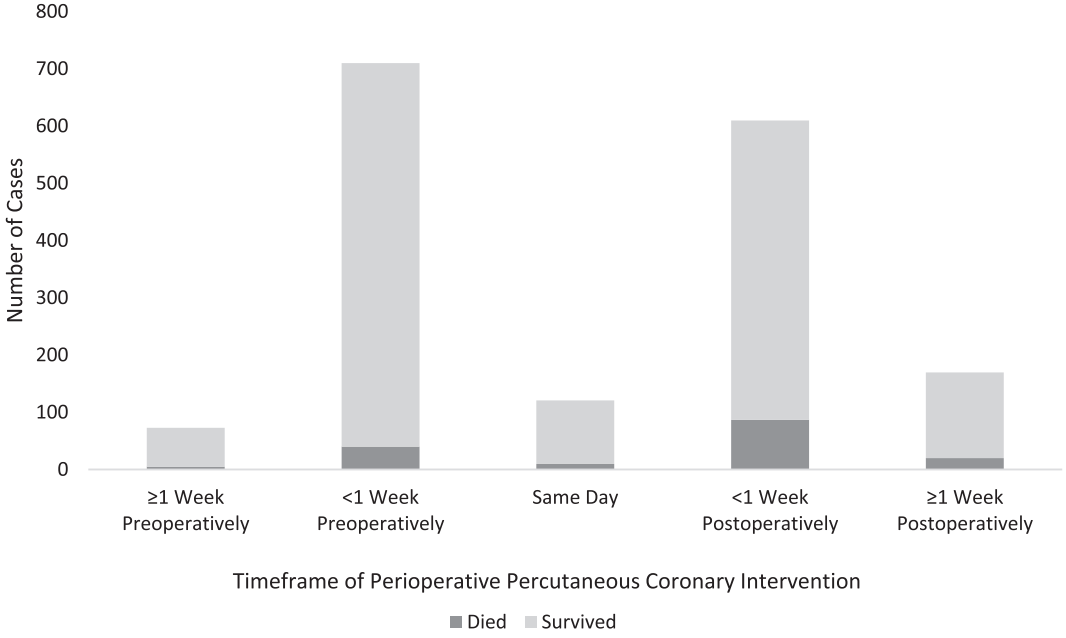

Fig. 1. Mortality of 1827 estimated discharges involving both hip fracture surgery and perioperative percutaneous coronary intervention (PCI) by timing of PCI. National Inpatient Sample, January 1st, 2010-September 30th, 2015.

Table 3
Hospitalization Variables of Hip Fracture Patients by Cohort[1].

Variable	N (%)*				*P*-value
	All Discharges (n = 1535,917)	PCI (n = 1827)	No PCI (n = 28,670)	No AMI (n = 1505,095)	
Hospital stay (days)†	5.9 ± 4.7	13 ± 9.8[a,b]	10 ± 7.4[a]	5.8 ± 4.6	< 0.001
Cost (USD)†	17,806.61 ± 13,744.03	45,566.64 ± 25,203.57[a,b]	29,520.72 ± 24,276.17[a]	17,678.66 ± 13,529.84	< 0.001
Discharge disposition					
Routine/home health	230,864 (15)	184 (10)[a,b]	1797 (6.2)[a]	228,898 (15)	< 0.001
Care facility	1272,430 (82)	1490 (81)	22,839 (80)[a]	1248,102 (83)	< 0.001
Died	28,875 (1.9)	161 (8.9)[a,b]	3959 (14)[a]	24,768 (1.6)	< 0.001

[1] AMI, acute myocardial infarction; PCI, percutaneous coronary intervention.
* Percentages and individual cell counts may not sum to total cell counts because of sampling weight application and rounding.
† Reported as mean ± standard deviation.
[a] Significant difference with no AMI cohort.
[b] Significant difference with no PCI cohort.

Discussion

In this study, using a large national U.S. database, we found that 1.9% of hip fracture patients sustained a perioperative AMI, and that 0.01% of hip fracture patients sustained a perioperative AMI and underwent in-hospital PCI. Hip fracture patients with AMI with no PCI had higher rates of in-hospital mortality than those who had AMI with PCI, both of whom had significantly higher rates of mortality than those with no AMI. Similarly, the no PCI and PCI cohorts had increased adjusted odds of mortality compared to the no AMI cohort, with the greatest adjusted odds of mortality in the no PCI cohort. There were no differences in in-hospital mortality rates based on timing of PCI relative to hip fracture surgery. Patients in the no PCI and PCI cohorts had higher rates of all complications than those in the no AMI cohort. The PCI cohort also had a higher rate of bleeding complications than the no PCI cohort, whereas the AMI cohort had a higher rate of transfusions than the PCI cohort. The PCI cohort had a greater length of stay and hospitalization cost than the no PCI and no AMI cohorts, which were in turn higher in the no PCI than the no AMI cohort.

Prior studies have reported varying rates of perioperative AMI in hip fracture patients. A study using the Danish National Patient Registry found a 1.15% rate of AMI in hip fracture patients at 30 days of follow-up [24], which is similar to our findings; however, their study did not include preoperative AMI. A separate study using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) reported that AMI occurred a median of 3 days postoperatively in geriatric hip fracture patients, with an interquartile range of 1 to 5 days [25], suggesting that most postoperative AMI in these patients occurs during the perioperative period. Other studies have reported higher rates of perioperative AMI in hip fracture patients, ranging from 6% to 37% [9–14]. This is likely due to variation in definitions of AMI, inclusion and exclusion criteria, and follow-up times. Moreover, these were all single center studies, whereas we utilized a national dataset, which is more likely to be representative of the national hip fracture population in the U.S.

We found that hip fracture patients who sustained an AMI that was treated with perioperative PCI had lower in-hospital mortality than hip fracture patients with perioperative AMI without PCI. This suggests that patients who develop an AMI that cannot be treated with PCI are more likely to be experiencing type 2 than type 1 AMI and are a systemically sicker population. This is further supported by our findings that the no PCI cohort had higher rates of cardiac arrhythmias, uncomplicated diabetes, peripheral vascular disorders, and pulmonary circulation disorders than the PCI cohort. A previous study also found that patients with type 2 AMI had higher comorbidities than those with type 1 AMI, including diabetes, previous non-STEMI ACS, impaired renal function, anemia, and atrial fibrillation, were less likely to undergo invasive treatment, and had higher 1-year crude mortality [26]. The increased survival rate we found in hip fracture patients who had an AMI and underwent perioperative PCI is also in line with a study by Rostagno et al [11]. In that study, 92 of 1030 hip fracture patients (8.9%) sustained an AMI postoperatively, of whom 16 (17.3%) underwent PCI in the early postoperative period. Coronary vascularization was found to be independently associated with improved survival at one year postoperatively, with 13 of 16 patients (81%) who underwent PCI alive at one year, in contrast to 31 of 65 hip fracture patients with AMI (42%) who were treated with medical therapy alone. Our findings, which utilized a national dataset, support the previous literature to suggest that PCI should not be delayed in hip fracture patients. It is thus important to identify hip fracture patients who are more likely to require perioperative PCI for AMI and to involve early cardiology consultation in order to better optimize these patients perioperatively and to improve their outcomes.

Interestingly, we found no differences in mortality by timing of PCI relative to hip fracture surgery. This finding suggests that if a hip fracture patient sustains an AMI requiring PCI, the timing of the PCI relative to hip fracture surgery does not affect the risk of mortality. AMI requiring PCI should be addressed emergently, consistent with guidelines by the American College of Cardiology/American Heart Association (ACC/AHA) [27], but PCI should also not be a contraindication to undergo surgery to fix a hip fracture once the patient is medically stable [27]. Nonetheless, it is important for providers to be aware of the increased risks of mortality and complications in hip fracture patients who sustain a perioperative AMI that may warrant PCI in order to better manage patients, as well as to counsel patients and family members regarding prognosis.

Hip fracture patients who had AMI both with and without perioperative PCI had higher rates of bleeding complications than hip fracture patients without AMI in our study. Similarly, in comparison to hip fracture patients without AMI, transfusion rates were higher for hip fracture patients who had AMI with and without PCI, and were highest in the no PCI group. These findings may in part be explained by the use of anticoagulant and antiplatelet therapies utilized for management of AMI and as adjunctive therapy in PCI. Moreover, lower transfusion thresholds (higher hemoglobin levels) are frequently utilized for patients with a history of cardiovascular disease, although studies have shown that restrictive transfusion thresholds yield similar outcomes in these patients compared to those without such comorbidities [28]. Additionally, patients are kept on dual antiplatelet therapy for at least several months following PCI and AMI [29], further increasing the risk of bleeding, especially at the surgical site. Stopping these medications early can result in catastrophic cardiac complications, such as stent thrombosis in patients who undergo PCI [30]. The operative team should be aware of both the increased risk of bleeding complications and the likely need for transfusions in this already high risk patient population. Further studies are required to evaluate the nature of bleeding complications experienced by hip fracture patients who experience perioperative AMI with and without PCI, as well as the difference in transfusion rates between them.

We also found that hip fracture patients undergoing PCI utilized more hospital resources than those who had AMI without PCI and those without AMI, including increased length of stay and hospitalization cost. This further highlights the importance of identifying risk factors not only for perioperative AMI in hip fracture patients, but also for PCI, in order to identify strategies to mitigate costs and resource utilization. Additionally, hip fracture patients who underwent PCI had a higher rate of discharge to home than those who had AMI without PCI, further suggesting that patients who sustain an AMI not amenable to PCI likely represent a systemically sicker population.

There were several limitations to this study. First, this was a retrospective study using the NIS, which is limited to inpatient hospital stays and thus precluded longer term follow-up. Another limitation of the NIS is that it is based on ICD-9 coding, which may have errors in coding and information entry. However, the database is subject to periodic quality checks for internal and external validation. In addition, we were unable to verify the indications for PCI in our cohort. However, the primary indication for PCI is an acute obstruction within a coronary artery resulting in ischemia to the myocardium, which we presumed to be the indication in these patients [18]. Another limitation is that NIS data does not provide information on medications, which would have been insightful given the antithrombotic and antiplatelet regimens that are prescribed following PCI. Also, we were unable to infer causality between PCI and mortality and complication rates in hip fracture patients with AMI, only associations. Finally, due to the nature of reporting by ICD-9 coding through NIS, we were unable

to distinguish whether patients experienced type 1 or type 2 AMI, which have differing etiologies and treatment strategies. However, strengths of this study are that the NIS provides a large, nationally representative sample, and this is the first study to assess the incidence of perioperative AMI and PCI in hip fracture patients using a U.S. national database, as well as mortality and complication rates in these patients.

Conclusion

Based on a national sample of patients in the U.S., we found that perioperative AMI occurs in about 1 in 50 hip fracture patients, and about 1 in 20 hip fracture patients who experience perioperative AMI undergo PCI. Both perioperative AMI not treated with PCI and those that are treated with PCI in hip fracture patients are associated with an increased risk of inpatient mortality and complications compared to hip fracture patients without AMI. Hip fracture patients undergoing perioperative PCI have decreased mortality and an increased rate of discharge to home compared to those who have AMI without perioperative PCI, but a higher rate of bleeding complications and increased length of stay and hospital costs. It is important for providers to understand the increased morbidity and mortality associated with AMI in hip fracture patients, as well as the potential risks and benefits of undergoing perioperative PCI in such patients who warrant this procedure, in order to better advise and manage them. Identifying the risk factors associated with perioperative AMI and PCI in hip fracture patients is crucial in order to optimize these patients perioperatively and to consult cardiology services as appropriate.

Declarations of Competing Interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2021.01.009.

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