



## Original research

## Periprosthetic Hip Fractures Outside the Initial Postoperative Period: Does Time from Diagnosis to Surgery Matter?

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## ABSTRACT

**Background:** Despite an increasing incidence and associated morbidity, the optimal timing for the surgical management of periprosthetic hip fractures remains unknown. This study sought to explore whether time to surgery was associated with medical or surgical complications.

**Methods:** A retrospective review of Medicare data from 2010 to 2014 was performed using PearlDiver. All patients with a periprosthetic hip fracture greater than 90 days from surgery and undergoing open reduction internal fixation (ORIF) or revision total hip arthroplasty (RTHA) were included. Time to surgery was measured from diagnosis and dichotomized at 48 hours.

**Results:** Of 342 patients undergoing ORIF, 269 (79%) had surgery within 48 hours. Of 255 patients undergoing RTHA, 142 (56%) had surgery within 48 hours. For ORIF, surgery more than 48 hours after diagnosis was associated with an increased rate of 30-day deep vein thrombosis or pulmonary embolism (15% vs 7%,  $P = .03$ ), which remained after adjustment (odds ratio [OR]: 2.71, 95% confidence interval [CI]: 1.11–6.45). A similar association was seen for RTHA (12% vs 6%,  $P = .09$  and OR: 2.61, 95% CI 1.01–7.24). For RTHA, surgery more than 48 hours after diagnosis was associated with an increased rate of 90-day periprosthetic joint infection (12% vs 4%,  $P = .007$ ), which remained after adjustment (OR: 3.86, 95% CI: 1.36–12.72). A similar but not significant association was seen for ORIF (7% vs 3%,  $P = .18$  and OR: 2.65, 95% CI: 0.73–8.91).

**Conclusions:** Among Medicare patients with a periprosthetic hip fracture, time to surgery greater than 48 hours was associated with increased medical and surgical complications.

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## Introduction

The increasing provision of total hip arthroplasty in the setting of prevalent osteoporosis and longer life expectancy is producing an expanding number of periprosthetic hip fractures [1,2]. These patients require complex care and are at considerable risk of medical and surgical morbidity. Despite substantial differences in the surgical management of periprosthetic and native hip fractures, nonsurgical aspects of periprosthetic hip fracture care are often guided by data from native hip fractures [3,4]. Although extensive research on time to surgery after native hip fractures has found

longer times, especially those beyond 36 to 48 hours, and are associated with increased complication rates including mortality, this may not be true after periprosthetic fractures [5–10].

Research on time to surgery in periprosthetic hip fractures is sparse, reflecting the challenges of studying a more heterogeneous and rare condition. The few available studies of these patients have reported mixed results although they have been limited by inclusion of patients in the initial postoperative period, heterogeneity of surgical management type, and modest sample sizes [11–13]. Patients who suffer fracture in the initial postoperative period likely differ significantly from those who suffer fracture years later in many ways. These acute fractures occur in patients who have recently undergone medical optimization and remain in closer contact with their surgeon. In addition, implant records and the necessary implants themselves are likely more readily available. From the surgical management side, planning for open reduction

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internal fixation (ORIF) can differ significantly from a revision total hip arthroplasty (RTHA). These differences in patients, surgery, and surgeon may be associated with time to surgery and the rate of complications.

This study sought to explore whether time to surgery for periprosthetic hip fractures that occurred outside the initial post-operative period was associated with medical or surgical complications when stratified by surgical management type.

**Material and methods**

A retrospective review of Medicare data from 2010 to 2014 was performed using the PearlDiver platform (PearlDiver Inc., Colorado Springs, CO). All patients with an International Classification of Diseases (ICD)-9 code for a periprosthetic proximal femur fracture and a Current procedural terminology code for either ORIF or RTHA were identified. Patients with a fracture in the initial postoperative period, defined as within 90 days of undergoing total hip arthroplasty, were excluded.

Time to surgery was measured relative to the time of diagnosis. To address concerns regarding an earlier and less-specific diagnosis of hip fracture being later modified to the diagnosis of periprosthetic proximal femur fracture, all related diagnosis codes were also searched. The earliest time for any related diagnosis code was used in the calculation of time to surgery. Given the relatively modest sample size, even in this large administrative claims database, and in effort to increase clinical applicability, patients were dichotomized based on a time from diagnosis to surgery of less than or more than 48 hours, which is both clinically intuitive and consistent with some prior studies.

The outcomes assessed were those ICD-9 diagnosis codes monitored and reported by the Centers for Medicare and Medicaid Services including mechanical complications (dislocation, broken implant, implant loosening), periprosthetic joint infection (PJI), wound infection, acute myocardial infarction, pneumonia, sepsis, surgical site bleeding, pulmonary embolism (PE), as well as other complications including blood transfusion, urinary tract infection, readmission, reoperation, and emergency department (ED) visits. For the Centers for Medicare and Medicaid Services complications reported as a group such as mechanical complications, the specific

diagnosis code leading to inclusion in this group was identified when possible (Appendix).

Given the clinical differences in ORIF and RTHA as surgical treatments which are likely associated with some clinical outcomes and their known association with time to surgery, all analyses were a priori stratified by ORIF and RTHA, even recognizing the potential loss of power. Descriptive statistics were calculated for demographic and clinical variables with comparisons of continuous variables performed using Student’s *t*-test and those of categorical variables using the chi-squared test. Univariable associations between the dichotomized time-to-surgery variable and outcome variables were performed using the chi-squared test with proportions, and *P* values, reported. Multivariable associations were performed using logistic regression to adjust for age, gender, Charlson comorbidity index, region, diabetes, obesity, and tobacco use, with odds ratios and 95% confidence intervals reported. No attempt was made to adjust the study-wise alpha for multiple comparisons, given the hypothesis-generating nature of this work. Statistical significance was set at an alpha threshold of 0.05. All analyses were performed using R software accessed through the PearlDiver platform (version 3.5.0, Vienna, Austria).

**Results**

In total, 790 patients were identified with periprosthetic proximal femur fracture and having undergone either ORIF or RTHA; 193 (24%) patients with acute periprosthetic fractures were excluded, leaving 597 patients in the study group. Of the 342 patients who underwent ORIF, 269 (79%) had surgery within 48 hours. Of the 255 patients who underwent RTHA, 142 (56%) had surgery within 48 hours. The median time to surgery in the both the ORIF and RTHA groups who underwent surgery beyond 48 hours was 4 days (interquartile range: 3, 6). Within the surgical treatment groups, we did not observe time to surgery to be significantly associated with clinical characteristics including age, Charlson comorbidity index, gender, proportion of patients with obesity, tobacco use, diabetes, or region (Table 1).

Of patients who underwent ORIF, those who underwent surgery within 48 hours had a lower rate of deep vein thrombosis (DVT) or PE within 30 days of surgery and a lower rate of visits to the ED

**Table 1**  
Characteristics of patients with periprosthetic femur fracture by surgery type and timing.

Characteristic	ORIF surgical timing			RTHA surgical timing		
	Within 48 h	After 48 h	<i>P</i> value	Within 48 h	After 48 h	<i>P</i> value
Total n	269	73		142	113	
Sex						
Female	201 (74.7%)	54 (74.0%)	.90	96 (67.6%)	72 (63.7%)	.52
Male	68 (25.3%)	17 (23.3%)		46 (32.4%)	41 (36.3%)	
Age (in years)						
Younger than 65	25 (9.3%)	4 (5.5%)	.32	15 (10.6%)	15 (13.3%)	.52
65 to 69	28 (10.4%)	6 (8.2%)		14 (9.9%)	18 (15.9%)	
70 to 74	34 (12.6%)	8 (11.0%)		17 (12.0%)	15 (13.3%)	
75 to 79	38 (14.1%)	9 (12.3%)		25 (17.6%)	20 (17.7%)	
80 to 84	51 (19.0%)	23 (31.5%)		30 (21.1%)	22 (19.5%)	
85 and older	93 (34.6%)	23 (31.5%)		41 (28.9%)	23 (20.4%)	
CCI (Avg. ± SD)	8.13 ± 3.78	8.89 ± 3.85	.13	7.34 ± 3.48	7.77 ± 3.77	.35
Obesity						
Yes	80 (29.7%)	17 (23.3%)	.28	40 (28.2%)	38 (33.6%)	.35
No	189 (70.3%)	56 (76.7%)		102 (71.8%)	75 (66.4%)	
Diabetes						
Yes	181 (67.3%)	47 (64.4%)	.64	88 (62.0%)	70 (61.9%)	.99
No	88 (32.7%)	26 (35.6%)		54 (38%)	43 (38.1%)	
Tobacco						
Yes	107 (39.8%)	36 (49.3%)	.14	68 (47.9%)	61 (54.0%)	.33
No	162 (60.2%)	37 (50.7%)		74 (52.1%)	52 (46.0%)	

CCI, Charlson Comorbidity Index.

**Table 2**  
Univariable analysis of medical complications of patients with periprosthetic femur fracture by surgery type and timing.

Characteristic	ORIF surgical timing			RTHA surgical timing		
	Within 48 h	After 48 h	<i>P</i>	Within 48 h	After 48 h	<i>P</i>
Myocardial infarction within 7 d of surgery	5 (1.9%)	1 (1.4%)	.78	2 (1.4%)	0 (0%)	.21
Pneumonia within 7 d of surgery	5 (1.9%)	4 (5.5%)	.09	6 (4.2%)	2 (1.8%)	.26
Urinary tract infection within 7 d of surgery	41 (15.2%)	18 (24.7%)	.06	23 (16.2%)	14 (12.4%)	.39
Pulmonary embolism within 30 d of surgery	8 (3.0%)	4 (5.5%)	.30	5 (3.5%)	2 (1.8%)	.40
DVT or PE within 30 d of surgery	<b>19 (7.1%)</b>	<b>11 (15.1%)</b>	<b>.03</b>	8 (5.6%)	13 (11.5%)	.09
ED visits within 30 d of surgery	<b>27 (10.0%)</b>	<b>14 (19.2%)</b>	<b>.03</b>	<b>16 (11.3%)</b>	<b>23 (20.4%)</b>	<b>.04</b>

*P*-value <.05 were given in bold.

within 30 days of surgery than patients who underwent surgery further from diagnosis (Table 2). Of patients who underwent ORIF, no other statistically significant univariable associations were observed between time to surgery and medical complications. After adjusting for potential confounders, surgery after 48 hours was still associated with a statistically significant increased rate of DVT/PE within 30 days of surgery (Table 3).

Of patients who underwent RTHA, no statistically significant univariable associations were seen between time to surgery and medical complications (Table 2). After adjusting for potential confounders, however, surgery after 48 hours was associated with an increased rate of DVT or PE within 30 days of surgery and an increased rate of visits to the ED within 30 days of surgery (Table 3).

Of patients who underwent ORIF, no statistically significant univariable associations were seen between time to surgery and surgical complications (Table 4). There was also no statistically significant multivariable association between time to surgery and surgical complications (Table 5).

Of patients who underwent RTHA, those who had surgery within 48 hours had a lower rate of PJI within 90 days of surgery (Table 4). Of patients who underwent RTHA, no other statistically significant univariable associations were seen between time to surgery and surgical complications. After adjusting for potential confounders, surgery after 48 hours was still associated with an increased rate of PJI within 90 days of surgery (Table 5).

## Discussion

Among patients with a periprosthetic hip fracture outside the initial postoperative period, time from diagnosis to surgery greater than 48 hours was associated with an increased risk of medical and surgical complications. For patients undergoing RTHA, surgery beyond 48 hours was associated with an increased rate of DVT or PE within 30 days of surgery, an increased rate of ED visits within 30 days of surgery, and an increased rate of PJI within 90 days of surgery. For patients undergoing ORIF, surgery beyond 48 hours was associated with an increased rate of DVT or PE within 30 days of surgery.

**Table 3**  
Multivariable association of time to surgery and medical complications.

Characteristic	ORIF time to surgery	RTHA time to surgery
	After 48 h <sup>a</sup> OR [95% CI]	After 48 h <sup>a</sup> OR [95% CI]
Myocardial infarction within 7 d of surgery	0.59 [0.03–4.41]	–
Pneumonia within 7 d of surgery	2.96 [0.64–12.96]	0.26 [0.02–1.56]
Urinary tract infection within 7 d of surgery	1.86 [0.93–3.63]	0.79 [0.36–1.68]
Pulmonary embolism within 30 d of surgery	2.25 [0.52–8.63]	0.37 [0.04–2.39]
DVT or PE within 30 d of surgery	<b>2.71 [1.11–6.45]</b>	<b>2.61 [1.01–7.24]</b>
ED visits within 30 d of surgery	<b>2.08 [0.96–4.40]</b>	<b>2.31 [1.11–4.91]</b>

OR, odds ratio.

<sup>a</sup> The surgery within 48 h of diagnosis group was used as the reference.

Prior studies examining the association of time to surgery with complications in patients with a periprosthetic hip fracture have reported mixed results. Most recently, Bovonratwet et al. reviewed a series of 681 patients with periprosthetic hip fractures using National Surgical Quality Improvement Program (NSQIP) data and found no association between time to surgery greater than 48 hours and any of the 30-day outcomes tracked in this database on multivariable analysis with the exception of extended length of stay [11]. Their modeling process used backward selection and did not include time to surgery. On univariable analysis, associations with urinary tract infections and readmission were reported. This study did not exclude patients who were still in the initial postoperative period of their initial arthroplasty and did not stratify by surgery type although they did report surgery type was associated with time to surgery.

There have also been 3 single-institution retrospective reviews reporting on the association between time to surgery and complications in patients with periprosthetic hip fractures. Sellan et al. [14] reported on a mixed series of 180 patients at their institution who had a periprosthetic hip or knee fracture involving the femur. Time to surgery greater than 48 hours was not significantly associated with complications in this study although it was non-statistically significantly associated with increased rates of both infection and 12-month mortality. This study did not exclude patients who were still in the initial postoperative period and did not stratify by surgery type although they did report surgery type was associated with time to surgery.

Griffiths et al. reported on 60 patients with a periprosthetic hip fracture at their institution over a 5-year period [12]. A time to surgery greater than 72 hours was associated with an increased rate of grouped complications. This study did not exclude patients who were still in the initial postoperative period, did not stratify by surgery type, and did not adjust for comorbidities. Finally, Bhattacharyya et al. evaluated 106 patients with a periprosthetic femur fracture at their institution [15]. Time to surgery greater than 48 hours was associated with an increased 1-year mortality rate even after adjusting for comorbidities and after performing sensitivity analyses to remove patients delayed for medical clearance. This

**Table 4**  
Univariable analysis of surgical complications of patients with periprosthetic femur fracture by surgery type and timing.

Characteristic	ORIF time to surgery			RTHA time to surgery		
	Within 48 h	After 48 h	P	Within 48 h	After 48 h	P
Reoperation within 30 d of surgery	0 (0%)	0 (0%)	—	3 (2.1%)	3 (2.7%)	.78
Periprosthetic joint infection within 90 d of surgery	9 (3.3%)	5 (6.8%)	.18	<b>5 (3.5%)</b>	<b>14 (12.4%)</b>	<b>.007</b>
Mechanical complication within 90 d of surgery	9 (3.3%)	5 (6.8%)	.18	32 (22.5%)	30 (26.5%)	.46

P-value <.05 were given in bold.

study did exclude patients who were in the initial postoperative period but did not stratify by surgery type.

Given the current results and prior literature, it may be safest to assume that longer time to surgery for periprosthetic hip fractures outside the initial postoperative period is associated with increased complications as has been shown for patients with native hip fractures. In the study by Bhattacharyya et al, they compared the 1-year mortality of patients with a periprosthetic hip fracture with that of those with a native hip fracture and found them not to be significantly different [15]. A similar study by Haughom et al. using NSQIP data and propensity score matching to compare periprosthetic and native hip fractures found the 2 groups had similar 30-day mortality. That group found that periprosthetic hip fractures were associated with increased rates of other serious adverse events [16].

In the present study, the magnitude and statistical significance of some associations were altered by adjusting for confounders. For instance, patients undergoing RTHA greater than 48 hours from diagnosis were more likely to have a DVT or PE within 30 days of surgery in a statistically significant fashion only after adjustment for confounders, which also slightly increased the magnitude of this association. For patients undergoing ORIF greater than 48 hours from diagnosis, they were statistically significantly more likely to return to the ED within 30 days of surgery on univariable testing but not after adjusting for confounders although the magnitude of the association remained similar. These changes underscore the necessity of adjusting for confounding as much as possible. The associations reported should hopefully be largely independent of age, sex, and comorbidities although other confounders not recorded in the database used likely exist.

The degree to which the associations reported here may be magnified by residual confounding is unknown. Patients with more complex medical issues may require additional time for risk stratification and optimization, which may also be associated with complications. While we attempted to adjust for this using a common comorbidity index, this may not adjust for all potential confounding. While the association with thromboembolism seems biologically plausible, given a longer duration of relative immobility associated with time to surgery, the association with PJI is more uncertain. It is possible that patients with more complex fractures requiring more extensive revision surgery have a longer duration from diagnosis to surgery to allow for surgical planning and that a more extensive surgery is associated with increased complications. This, in part, may underlie the association with PJI. It is also

possible, however, that physical and systemic inflammation including swelling and the acute inflammatory response continues to rise during this period and that patients are more vulnerable to surgical complications the further out from injury.

Whether reducing the time to surgery would translate into reduced complications as opposed to simply altering the complication profile is unknown. Patients with periprosthetic hip fractures frequently require complex care including medical optimization and surgical planning. There may also be a time point beyond which no further gains are achieved. For instance, a randomized controlled trial of patients with native hip fractures found that attempting surgery within 6 hours of diagnosis was not associated with improved outcomes compared with routine care which was 24 hours in this trial [17]. Unfortunately, given the limitations of small sizes and heterogeneity within patients with periprosthetic hip fractures, using retrospective data to identify an inflection point or obtaining prospective data to test an intervention may not be feasible.

Even if shorter times to surgery can result in decreased complications, there may be practical constraints on achieving this in all environments. It is also important to note that this study did not include patients with fracture in the early postoperative period and these patients likely have different medical and surgical risk profiles as well as practical differences that affect their care. The results from our study, although limited, suggest that expeditious care of periprosthetic hip fractures, when safely possible, is likely to be associated with lower complication rates such as DVT, return to the ED, and infection.

This study should also be interpreted within the context of its methodological limitations. The retrospective nature of the review as well as the inherent limitations of large databases including the use of billing and procedural codes as well as the lack of granularity apply to this study. In addition, this analysis of Medicare billing records only allows for analysis based on the date on which a particular diagnosis or procedure is coded, which results in a loss of variation. While many of the demographic and outcome measures of interest were available, there were no functional measures, and the study was unable to assess mortality. Furthermore, residual confounding may exist from the heterogeneity in DVT prophylaxis and perioperative antibiotics. In addition, without radiographs or operative reports, the study was not able to further delineate differences in outcomes based on a more granular classification of periprosthetic fractures or treatment beyond what is found in diagnosis and procedural codes.

**Table 5**  
Multivariable association of time to surgery and surgical complications.

Characteristic	ORIF time to surgery	RTHA time to surgery
	After 48 h <sup>a</sup> OR [95% CI]	After 48 h <sup>a</sup> OR [95% CI]
Reoperation within 30 d of surgery	—	1.07 [0.16–7.02]
Periprosthetic joint infection within 90 d of surgery	2.65 [0.73–8.91]	<b>3.86 [1.36–12.72]</b>
Mechanical complication within 90 d of surgery	2.46 [0.63–9.18]	1.19 [0.66–2.16]

OR, odds ratio.

<sup>a</sup> The surgery within 48 h of diagnosis group was used as the reference.

## Conclusions

Among Medicare patients with a periprosthetic hip fracture, time to surgery greater than 48 hours was associated with increased rates of medical and surgical complications including both DVT or PE and PJI. Surgeons can use these data as a rationale to justify the resources needed to promote the most efficient care of these patients and proceed with surgery as soon as is safely possible. Given the complex care these patients require, however, work is needed to understand the optimal timing of surgery and how best to provide coordinated team-based care.

## Conflict of interest

The authors declare there are no conflicts of interest.

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## Appendix

Evaluating the patients who underwent revision total hip arthroplasty, the group that underwent surgery within 48 hours had 30 patients with solely mechanical complications, which included the following: 16 (53.3%) with mechanical loosening, 6 (20.0%) with dislocations, 3 (10.0%) with a broken prosthetic implant, 1 (3.3%) with both mechanical loosening and dislocation, 1 (3.3%) with both dislocation and broken prosthetic implant, and 3 (10%) with other unclassified mechanical complications. Of the 2 patients with both periprosthetic joint infection (PJI) and mechanical complications, 1 patient had both PJI and dislocation and 1 patient had both PJI and a broken prosthetic implant. For the delayed group, there were 25 patients with solely mechanical complications, which included the following: 6 (24.0%) with mechanical loosening, 9 (36.0%) with dislocations, 5 (20.0%) with a broken prosthetic implant, 1 (4.0%) with both dislocation and

broken prosthetic implant, and 4 (16.0%) with other unclassified mechanical complications. Of the 5 patients with both PJI and mechanical complications, 1 had mechanical loosening, 3 had dislocations, and 1 had a broken prosthetic implant. There were no differences in mechanical complications between the early surgery and delayed surgery groups.

In the open reduction internal fixation cohort treated within 48 hours, there were 9 patients who experienced solely mechanical complications, which included the following: 2 (22.2%) with mechanical loosening, 3 (33.3%) with dislocations, and 4 (44.4%) with a broken prosthetic implant. There were no patients with overlap between PJI and mechanical complications in this subgroup. For the delayed group, there were 4 patients with solely mechanical complications, which included the following: 1 (25.0%) with mechanical loosening, 1 (25.0%) with dislocation, and 2 (50.0%) with other unclassified mechanical complications. There was 1 patient with both PJI and mechanical loosening.