


Periprosthetic Fractures About the Hip: A Case-Matched Retrospective Analysis of Functional Outcomes Postrehabilitation

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J. Tristan Cassidy, MB BCh BAO, MCh¹, Joseph F. Baker, FRCS¹, Peter Keogh, FRCS¹, and Paddy Kenny, FRCS¹

Abstract

Introduction: Little research has examined postrehabilitation functional outcomes of periprosthetic hip fractures. Predicted functional deficits and acceptable rehabilitation outcomes for these patients are not established. This study aimed to compare functional outcomes of periprosthetic fractures to matched patients with total hip arthroplasty (THA). **Materials and Methods:** Cases with periprosthetic fracture (PPF) were matched for age, gender, and surgeon to primary THA cases. Only patients who had completed at least 1 year of rehabilitation were included. Western Ontario and McMaster Universities Arthritis Index (WOMAC) scores were calculated for all surviving cases with PPF and primary THA. Secondary outcomes included length of stay and mortality. Statistical analysis was performed using Microsoft Excel and the 2-tailed Wilcoxon signed rank test. A *P* value of <.05 was accepted as indicative of statistical significance. **Results:** We identified 25 patients with PPF. Three patients were unsuitable for functional assessment. Of the cases with PPF suitable for functional assessment, 14 (14/22) were male. The median age of the PPF and the THA groups was 71 years and 68 years respectively. The median WOMAC score for the PPF group was 26 (interquartile range [IQR] 5.5-49.5) compared to that of the primary THA group, 3 (IQR 2.0-24.5; *P* < .05). In the PPF group, there were 7 deaths and 3 of the surviving patients had significant complications. The median length of stay in the PPF group was 13 days (IQR 10.5-35) compared to the matched group of 5 days (IQR 5-8.5; *P* < .05). **Conclusion:** Patients with PPF have markedly poorer functional outcomes than age-, gender-, and surgeon-matched patients with THA as well as prolonged length of stay. Future research should target the identification of factors that may improve functional outcomes in this growing cohort.

Keywords

trauma surgery, geriatric trauma, hospitalist, physical medicine and rehabilitation, osteoporosis

Introduction

With the ever-expanding volume of total hip arthroplasties (THAs) and aging populations worldwide, there is an increasing incidence of periprosthetic hip fractures (PPFs).^{1,2,3} Patients with PPFs are time and resource intensive, and treatment varies according to patient physiology and the status of the implant. The status of the implant determines whether it is suitable for retention or requires revision.^{4,5,6}

The greater bulk of published material on periprosthetic fractures has investigated treatment options, mortality, post-operative complications, or need for reoperation.^{7,8,9,10,11} The limited research reporting postrehabilitation functional outcomes of PPFs is outlined in Table 1. Only 2 of the 14 identified studies targeted functional outcomes (Young et al and Zuurmond et al), while the other studies investigated clinical and radiological outcomes from varied surgical interventions, often focusing on a subset of the periprosthetic cohort.

It is known that periprosthetic fractures are notoriously difficult to treat and outcomes, for example, mortality, are generally

considered poor.²⁶ The majority of deaths from PPFs have been shown to occur shortly after operative fixation.¹⁰ This has left an unanswered question: What is the rehabilitation potential of patients who survive PPFs? Being a relatively new problem for surgeons, there is a paucity of data available which may be used to (1) measure the resulting decline in function following PPF and (2) provide a basis for realistic rehabilitation targets.

Our clinical observation is that patients who sustain PPF do not regain pre-morbid function and have significant functional deficit on completion of rehabilitation. This study aimed to investigate functional outcomes following periprosthetic fracture and

¹ Department of Orthopaedics, Connolly Memorial Hospital, Blanchardstown Dublin, Ireland

Corresponding Author:

J. Tristan Cassidy, Connolly Memorial Hospital, Mill Road, Blanchardstown, Dublin 15, Ireland.

Email: johntcassidy@rcsi.ie

Table 1. Outline of Other Studies Reporting Functional Outcomes Following Periprosthetic Fracture About the Hip.

Authors	Country	Year	Numbers	Outcome measure	F/U	Matched control	Fracture type ^a	Conclusion
Montalti et al ¹²	Italy	2013	47	HHS	48	Nil	All	Vancouver B2 and B3 fractures require stem revision
Zuurmond et al ²²	Holland	2010	79	OHS	65	Nil	All	Poorer OHS scores vs OHS scores reported for elective and revision THA
Young et al ²³	New Zealand	2008	232	OHS	6	Revision THA	All	Poorer functional outcomes vs elective revision THA
Anakwe et al ²⁴	United Kingdom	2008	28	Need for walking aid	4	Nil	All	LISS plate reasonable alternative to revision arthroplasty in select cases
Lindahl et al ²⁵	Sweden	2006	217	HHS	Not reported	Nil	All	Vancouver B fractures require surgery of the joint
McLauchlan et al ¹³	United Kingdom	1995	45	Nil recognized	9	Nil	All	Fractures with loose stems require revision
Fink et al ¹⁴	Germany	2012	32	HHS	32	Nil	B2 and B3	Stem revision gives reproducibly and good radiological and clinical results
Neumann et al ¹⁵	Germany	2012	55	HHS	67	Nil	B2 and B3	Use of modular stem in B2/B3 allows early mobilization and rehabilitation
Park et al ¹⁶	South Korea	2009	27	HHS	58	Nil	B2 and B3	Use of modular tapered fluted stem in B2/B3 allows early mobilization and rehabilitation
Agarwal et al ¹⁷	United Kingdom	2005	16	HHS	8	Nil	B1	B1 fractures can be managed with fixation, preferably using cables
Mulay et al ¹⁸	United Kingdom	2005	22	HHS	24	Nil	B2 and B3	Use of modular tapered fluted stem in B2/B3 allows early mobilization and rehabilitation
Ko et al ¹⁹	Hong Kong	2003	12	HHS	59	Nil	B2	Wagner stem is satisfactory prosthesis to manage B2 fractures in geriatric population
Sledge et al ²⁰	United States	2002	7	HHS	33	Nil	B2	Use of allografts and cables promotes fracture healing
Incavo et al ²¹	United States	1998	8	HHS	49	Nil	B2	Recommends use of long-stem revision with cables

Abbreviations: OHS, Oxford Hip Score; THA, Total Hip Arthroplasty; F/U, Mean Follow up in months; HHS, Harris Hip Score.

^a Classified by the Vancouver Classification

^b Clinical outcome was classified as good/fair/poor dependent on "integrity of fixation, refracture rate, and ability to perform activities of daily living analyzed against age, type of fracture, prosthetic alignment, loosening, and method of fixation."

quantify the persistent functional deficit caused specifically by the fracture episode. Therefore, patients were compared to controls matched for age, gender, and operating surgeon following primary THA. Secondary outcome measures include complications, morbidity, mortality, the need for reoperation, and the length of hospital stay.

Methods

Identification of Cases With PPFs and Matching to Joint Registry Cases

This study was performed with approval of institutional review board. We accessed our Hospital In-Patient Enquiry (HIPE, Health Service Executive, The Republic of Ireland) and cross-referenced with theater logbooks to identify patients undergoing surgery for PPF of the hip. All personal data were anonymized following collection. Data were collected for the period January 1, 2007 to October 31, 2013. This cutoff at October 2013 was selected so as to ensure 1-year follow-up was available at the commencement of the study. The identified patients with PPF were

matched for age, gender, and senior operating surgeon to joint registry cases from the National Orthopaedic Hospital, a separate elective orthopedic hospital. The data collected from the joint registry were deidentified prior to being used by the research team for analysis. In patients with PPF, accurate and complete records of the primary arthroplasty surgeries were not available. Consequently, the date of primary THA for the matched cohort was chosen so as to be as close as possible to the date of operative intervention for the PPF cohort. This facilitated similar rehabilitation and follow-up periods for each group. The American Society of Anesthesiologists (ASA) scores were not recorded in all cases, therefore it was not possible to match for preoperative ASA grade. Table 2 outlines the PPF cohort available for follow-up.

Collection and Collation of WOMAC Scores

Western Ontario and McMaster Universities Arthritis Index (WOMAC) scores were calculated on both the surviving cases with PPF and the matched patients retrieved from the Joint Registry of the National Orthopaedic Hospital.²⁷ The WOMAC scores are routinely collected by the joint registry team. For the

Table 2. Details of the Periprosthetic Fracture Cohort Available for Follow Up.

Patient no.	Age, years ^a	Sex	Year of surgery	ASA	Fracture ^b
1	74	Female	2008	II	B1
2	60	Male	2009	IV	B1
3	84	Female	2009	III	B1
4	75	Male	2009	II	B1
5	53	Female	2010	II	B1
6	80	Female	2010	I	B1
7	86	Male	2011	II	B1
8	48	Female	2011	I	B1
9	70	Male	2012	II	B1
10	94	Male	2010	II	B2
11	65	Male	2012	I	B2
12	42	Male	2012	III	B2
13	72	Male	2012	II	B2
14	75	Male	2010	II	B3
15	59	Male	2008	II	C

Abbreviation: ASA, American Society of Anesthesiologists Score

^a Age at time of surgery.

^b Vancouver classification.

PPF cohort, the WOMAC scores were calculated on clinical review at follow-up by the lead author. Four patients did not attend the follow-up. In these cases, the WOMAC scores were obtained via telephone by the lead author. Patients who were too infirm to complete a functional assessment or were cognitively impaired were excluded from the analysis. For patients who died, official dates of death were sourced from the national registration body in the Republic of Ireland.²⁸

Collection of Biochemical, Radiological, and Descriptive Data

Other data sources included theater logbooks, medical records, and radiographic records. The variables recorded included age, sex, fracture type as classified by the Vancouver Classification, ASA score at time of fixation, medical comorbidities, presence of pre- and postoperative infection of prosthesis, and whether or not secondary surgery at the PPF site was required.^{29,30} Fracture classification was extracted from the surgical notes and was confirmed in all cases by reexamination of the preoperative radiographs by 1 senior registrar (JFB).

Data management and statistical analysis were performed using Microsoft Excel (Health Service Executive, The Republic of Ireland), and the 2-tailed Wilcoxon signed rank test was used to test for statistical significance. A *P* value of <.05 was accepted as indicative of statistical significance. In the results, values reported are the median with interquartile ranges (IQR) in parentheses.

Results

Sample Description

There were 25 PPFs identified. No patient sustained more than 1 PPF. All 25 PPFs occurred greater than 30 days after

Table 3. Comparison of WOMAC Scores for Patients Matched For Age, Sex, and Consultant.^a

Patient	Periprosthetic fracture group				Matched control group			
	Age	Sex	F/U	WOMAC	Age	Sex	F/U	WOMAC
1	42	M	12	55	40	M	29	2
2	48	F	30	3	47	F	37	33
3	53	F	36	57	53	F	17	3
4	58	M	68	50	59	M	65	3
5	60	M	55	56	60	M	47	8
6	64	M	20	26	67	M	27	29
7	69	M	20	10	69	M	33	3
8	71	M	21	6	71	M	35	2
9	74	F	65	0	74	F	45	0
10	75	M	49	10	75	M	61	1
11	75	M	37	1	75	M	66	2
12	79	F	36	41	79	F	69	24
13	84	F	50	30	81	F	71	10
14	86	M	29	49	86	M	41	25
15	94	M	40	5	85	M	25	47

Abbreviations: F/U, Follow up; WOMAC, Western Ontario and McMaster Universities Arthritis Index.

^a Age matched within 4 years with the exception of patient no. 11 where closest age was taken from registry.

insertion of original implant. One fracture was intraoperative, during revision of a primary prosthesis. Three patients were excluded from functional assessment due to either cognitive impairment or severe illness (advanced cognitive decline [2] and acute hospital admission for multiorgan dysfunction [1]). Of the 22 remaining cases with PPF, 14 were male (14 of 22). There were 7 mortalities in the PPF group (7 of 25) and no mortalities in the THA group. No patients were lost to follow-up. The median age at surgery for the died patients with PPFs was 81.3 (IQR 80.7-84.5) years compared to a 71.7 years (IQR 59.5-77.7) in those completing the functional assessment. The median age of the matched group was 68.0 years (IQR 59.5-77.0). The median ASA grade for the died group was 4 (IQR 3-4), while the median in those available for follow-up was 2 (IQR 2-2). Of the patients with PPFs, 2 were managed with revision of the implant with the 13 others undergoing open reduction and internal fixation around the in situ implant. Of the fractures, 11 were around the primary implants. Of these 11, 1 had the acetabular cup, but not the stem, revised previously.

Functional Outcomes and Length of Stay

Table 3 compares WOMAC scores between the PPF group and the matched THA group. The median WOMAC score for the PPF group was 26 (IQR 5.5-49.5) compared to the primary THA group of 3 (IQR 2.0-24.5; *P* < .05). The median length of stay in the PPF group was 13 days (IQR 10.5-35) compared to the matched group of 5 days (IQR 5-8.5; *P* < .05). In all, 10 patients were discharged home, 4 to rehabilitation before home, and 1 patient was transferred to long-term care.

Table 4. Recorded Complications in the Periprosthetic Fracture Group.

Patient no.	Complication
5	Nonunion
7	Sepsis
7	Fast atrial fibrillation
15	Infection ^a
19	Lower respiratory tract failure
19	Atrial fibrillation
21	Multiorgan failure
21	Acute kidney injury
22	Acute pulmonary edema
22	Lower respiratory tract infection

^a Deep infection requiring eventual removal of femoral plate

Table 5. Details of Patients Who Died From Periprosthetic Fracture.

Patient no.	Age, years ^a	Sex	Year of surgery	ASA	Fracture ^b
16	80	Female	2011	IV	BI
17	82	Male	2011	IV	BI
18	81	Female	2007	IV	BI
19	86	Male	2007	IV	BI
20	80	Male	2009	II	BI
21	87	Male	2009	III	BI
22	77	Female	2011	III	C

Abbreviation: ASA, American Society of Anesthesiologists Score.

^a Age at time of surgery.

^b Vancouver classification.

Complications

One patient developed de novo infection following fixation, while 1 patient was known to have an infected prosthesis prior to PPF and was therefore not included as a complication secondary to PPF fixation. There were 10 recorded complications in 6 patients, of which 3 died. These complications are outlined in Table 4. Three patients required further surgery. The first case required revision open reduction and internal fixation using plate and screws (with preservation of the original prosthesis) for nonunion. The second case involved revision of the acetabular cup for recurrent dislocation. The third patient had removal of a femoral plate as part of the management of a chronic discharging sinus. There was no recorded complications in the THA group.

Mortality

Details of the PPF mortalities are outlined in Table 5. For deceased patients, the median time from operation to date of death was 10.6 months (IQR 0.5-24.6). For surviving patients with PPF, the median time from operative intervention to follow-up WOMAC score was 36.4 months (IQR 24.9-49.8), while the median time of follow-up for the matched cohort was 40.7 months (IQR 32.6-63.3). Of the 7 deaths, 3 were within 3 weeks of fixation with the other 4 occurring at greater than 6

months after operation. There were no mortalities in the THA group.

Discussion

The aim of this study was to investigate functional outcome following PPFs about the hip using a recognized scoring system and compare the findings to a matched cohort of patients who had undergone primary THA. Using data from a standardized joint registry and a recognized mobility outcome score, it was possible to match patients with PPF to patients who underwent primary arthroplasty and control for age, sex, and operating surgeon. We found that when both the PPF group and the control THA group had completed a year of rehabilitation, patients post-PPF fixation had markedly poorer WOMAC scores. Patients with PPF also had a significantly longer length of stay compared to patients who underwent primary arthroplasty.

To our knowledge, this study is the first of its kind comparing functional outcome of patients with following fixation and match to this degree. Zuurmond et al compared functional outcomes of PPF versus reported elective primary and revision arthroplasty outcomes but did not match the cases to controls. Lindahl et al examined quality of life (as measured by the EQ-5D index) in patients postfixation of PPFs when compared to patients 1-year posthemiarthroplasty but did not compare functional outcomes.^{22,23,25} Young et al performed a case series of patients undergoing revision arthroplasty following PPF matched to patients undergoing elective revision arthroplasty. However, patients undergoing open reduction and internal fixation without exchange of any prosthetic component were excluded from this study. With the inclusion of fractures in which the prosthesis is retained, and also by matching for operating surgeon as well as age and sex, we believe our study is novel.

Our finding that patients who sustain PPF have poorer functional outcomes is consistent with conclusions made by others. McLauchlan et al reported a decrease in activities of daily living in 17 of the 34 cases with PPF.¹³ In this study, functional outcomes were classified into good, fair, and poor based upon having no decrease, some decrease, and marked decrease in activities of daily living, respectively, but no validated functional outcome score was used. Zuurmond et al reported a Oxford hip scores on 35 patients with a mean follow-up period of 64.9 months.²² They found a significantly poorer Oxford hip score in patients who had a PPF around a revised implant compared to those who fractured around a primary implant. Young et al compared outcomes of 123 patients following PPF with patients undergoing elective revision THA (matched for age and sex) using the Oxford 12 hip score (OHS12).^{23,31} They showed a statistically significant increase in mean OHS12 for cases with PPF compared to cases with elective revision THA (29 vs 24, respectively).

Kamineni et al published a series that focused on using plate and cable fixation to manage PPF. They reported on 15 patients and found slightly disparate results to our study—3 requiring further surgery and 13 having reached pre-morbid mobility at

the time of discharge home.³² Unfortunately, without the use of an objective functional outcome score, meaningful comparison with this study is difficult. Anakwe et al reported on using Less Invasive Stabilisation System in 28 patients with PPF all aged older than 70 years.²⁴ In this study, 5 patients died, 5 were discharged to rehabilitation prior to eventual return home, 2 discharged directly home, and 2 to long-term care. In total, 9 of the surviving patients required placement to long-term care. These findings for postoperative mortality and complications are very similar to the findings in our study. Four patients required reoperation and 1 developed a deep infection post-operatively. All 5 deaths occurred within 1 year, which is similar to our own findings where 5 of the 7 deaths occurred within 1 year.

At 7 of 25, our cumulative mortality was higher than that quoted by others in the literature and is markedly higher than observed mortality rates following primary THA. Bhattacharyya et al compared survival of PPFs to a matched cohort of both patients with hip fractures and elective hip or knee arthroplasties and quoted a 1-year mortality rate of 11%.⁷ However, unlike Bhattacharyya et al, our study focused on PPF only about the hip. Interestingly, following Kaplan-Meier survival analysis Bhattacharyya et al concluded that patients with a PPF have an increased mortality rate compared with similar patients undergoing joint replacement and have a mortality rate similar to that of patients with hip fracture—this was despite the matched hip fracture cohort having a lower Charlson Comorbidity Index. This contrast in mortality rates for elective joint replacement and PPF is consistent with our study. It is worth noting that the median ASA in our mortalities was markedly higher than in the PPFs available for follow-up; therefore, the died group were much higher risk surgical candidates from the outset.

We acknowledge this study has some inherent limitations. With a total of 25 patients, our sample size was small; however, no patients were lost to follow-up. Periprosthetic fractures are a heterogeneous group of injuries with differing management strategies depending on whether the implant is loose; therefore, investigating PPFs as a single group may be seen as simplistic. We must also acknowledge that this is a retrospective study and we have relied on medical records being completed appropriately. As such, inherent to any study of this nature, it is possible that we have underestimated to incidence of complications in the postoperative course following PPF fixation. We also considered using a cohort of patients undergoing revision arthroplasty or hemiarthroplasty for intracapsular fracture as the control group. However, we concluded that using the primary arthroplasty group as a control made it more likely that only the PPF influenced changes in functional status from the original THA. Any identified difference in WOMAC score could then be better attributed to the PPF.

Conclusion

We found that following fixation of PPF, postrehabilitation functional outcomes were significantly poorer than an age-

surgeon- and gender-matched cohort who had undergone primary THA. Consistent with previous work, the median length of hospital stay was significantly longer in the fracture cohort reflecting the greater surgical complexity and cost associated with treating PPFs.

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