

**Operation rate is more than double revision rate for
periprosthetic femur fractures – a multicentre
retrospective observational study.**

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1. Title Page

Title: Operation rate is more than double revision rate for periprosthetic femur fractures

Running Title: A multicentre retrospective observational study

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2. Abstract and Key Words

Background: Periprosthetic femur fractures (PFF) following hip arthroplasty can lead to significant morbidity due to their impact on mobility and the need for surgery. Its incidence often measured by the prosthesis revision rate reported in joint replacement registries. However, many PFF are also treated with prosthesis retention and internal fixation. Minimally displaced and stable fractures may be treated without surgery. Knowledge of the difference between the number of femoral revisions for PFF (well reported in registries) and the number of surgeries for PFF overall would allow us to estimate the overall surgical burden. This study aims to determine the number of post-operative PFF in 3 hospitals and compare those treated with revision surgery to those PFF treated with internal fixation and femoral stem retention. By determining this difference, we can ascertain a more accurate estimate of the overall surgical burden of PFF. **Method:** Patients 50 years and older who sustained a post-operative PFF between 1 January 2011 and 31 December 2017 at three public hospitals were extracted from hospital records. The number of revision procedures was compared to the number of re-operations of any type. **Results:** There were 200 patients admitted for management of PFF. 143 (71.5%) required an operation of which 67 (47%) were revision arthroplasty. **Conclusion:** The overall surgical burden of PFF is approximately twice that represented by the revision rate.

Key Words:

Periprosthetic fractures

Revision surgery

Internal Fixation

Arthroplasty, Replacement, Hip

Hemiarthroplasty

3. Main Text

Introduction

Total hip arthroplasty (THA) has been the foundation for treating debilitating arthritic hip joint disease for decades¹. Hip replacement surgery is also pivotal for treating displaced intracapsular neck of femur fractures, which in the elderly population involves either THA or hemiarthroplasty (HA)². Despite the significant quality of life improvements³ and proven cost effectiveness⁴, complications of arthroplasty occur. Periprosthetic femur fractures (PFF) are one such complication that incur significant morbidity and mortality on patients who sustain this injury. Along with loosening, infection and dislocation, PFF represent one of the most common reasons for revision arthroplasty reported by joint replacement registries⁵⁻⁹. The total surgical burden of PFF (beyond revision) is rarely reported and is not known in Australia.

Joint replacement registries record the outcome of primary arthroplasty based on revision of the primary procedure, where the prosthesis is removed or replaced, in part or in whole. Most registries do not record complications that are not treated with revision surgery. PFF with stable prostheses can be treated non-operatively or with surgical fixation of the fracture. In these circumstances, where the prostheses are retained (not revised), cases of PFF would not necessarily be recorded by a registry. A similar situation occurs for infection after primary THA¹⁰, where registries may under report prosthetic joint infection between 33 to 40% by only including those treated with implant revision^{11, 12}.

The Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR) has reported that revision for fracture is the third most common reason for revision (20.3%) in THA performed for OA, after loosening (25.0%) and dislocation (21.1%)⁵. For a primary diagnosis of fractured neck of femur, fracture is the second most common reason for revision (27.4%), after dislocation (32.5%). Primary partial hip replacement (HA) occurs mainly to treat fractured neck of femur (>90%). Regarding, bipolar HA, PFF is the most likely reason for revision up to 10 years (24.8% of all revisions). Given that only revision arthroplasty procedures are reported in the Australian registry, these figures do not include all surgically managed PFF. Therefore, the overall surgical burden of PFF is not well known.

This study aims to determine the number of PFF presenting to three Sydney hospitals between 2011 and 2017 and compare those treated with revision hip surgery (with or without additional fixation) to those PFF treated with internal fixation and femoral stem retention. By determining this difference, we can ascertain a more accurate estimate of the overall surgical burden of PFF.

Methods

Patients 50 years or older who sustained a post-operative PFF between 1 January 2011 and 31 December 2017 at three public hospitals (Liverpool Hospital, St George Hospital and The Sutherland Hospital; two trauma centres and one metropolitan hospital) in NSW, Australia were identified from hospital electronic records. Cases were isolated by extracting discharge records with the primary or other diagnoses documenting “periprosthetic femur fracture”, “periprosthetic femoral fracture” or “periprosthetic hip fracture”. Medical records were also obtained using the International Classification of Diseases and Related Health Problems (ICD-10) coded diagnoses outlined in Table S1 – of note, all femoral fractures were screened to account for cases not specifically coded for a diagnosis of PFF. Orthopaedic procedure records and departmental audits were also used at one hospital as a third method to select patients. Intraoperative fractures were excluded. Operation reports, radiographs, computed tomography images and discharge summaries were reviewed to determine eligibility. Demographic data for each patient was collected including age, gender, length of stay (LOS) and mechanism. Fracture type (Vancouver classification¹³) and treatment (revision surgery alone, revision surgery with internal fixation, internal fixation alone or non-operative) were recorded. Ethical approval was granted at all sites.

PFF are evaluated by the well established¹³ and validated¹⁴ Vancouver classification which categorises fractures around the femoral stem based on their anatomic location. Type A fractures are trochanteric (greater or lesser trochanters), type B are diaphyseal (from the trochanteric region to the distal tip of the femoral stem) and type C are distal to the stem of

the prosthesis (excluding supracondylar knee fractures). An established treatment algorithm based on the classification exists and is dependent on the type of fracture, the stability of the stem and the quality of bone¹⁵.

The primary outcome was to determine the overall operative treatment for PFF compared to revision surgery. Secondary outcomes were to compare the rates of revision and overall surgery based on fracture pattern and implant fixation techniques.

Results

Two hundred patients met the inclusion criteria and sustained a post-operative PFF between 1 January 2011 and 31 December 2017. **No patient had more than one fracture and none were acute intra- or post-operative fractures.** The age range was from 50 to 101 years old with a mean of 82.4. Female gender predominated (62.0%). A fall from sitting or standing height represented 90.5% of all PFF. Primary THA represented 84% of PFF detected. Uncemented stems represented 51.5% of all PFF. Table 1 outlines the demographic data.

There were 143 operations performed on patients who sustained a PFF out of the 200 PFF detected (71.5%). Of these, 76 patients (53.1%) required ORIF, 57 (39.9%) required revision and ORIF and 10 (7.0%) required revision alone (Table 2). The majority of operations were for Vancouver B fractures (77.6%). There were 57 PFF (28.5%) that did not require or undergo surgical treatment. Revision procedures were more common in cementless primary femoral stems with an odds ratio (OR) of 2.37 (Table 3). Accordingly, the overall operative rate for PFF is 2.1 times higher than for revision arthroplasty alone.

Discussion

We compared the overall rate of surgery to the rate of surgery involving prosthesis revision and determined the overall surgical burden of PFF to be over twice that for revision of the prosthesis. Given that the approximate 10-year rate of revision for PFF is 1% in THA performed for OA⁵, the overall rate of surgery for PFF over 10 years is likely to be approximately 2%.

Determining the incidence of PFF is challenging. Studies show the incidence of PFF ranges widely from 0.1% to 18%¹⁶⁻²¹. In a large study of THA reported in the Swedish Hip Arthroplasty Register, the cumulative incidence for revision surgery over 21 years ranged between 2.5 and 9% with 5.1% of those revised being for fracture²². Bozic *et al.* (2009) used the USA Nationwide Inpatient Sample database between 2005 and 2006 to calculate that PFF represented 6.2% of all revisions in that sample, with dislocation (22.5%), component loosening (19.7%) and infection (14.8%) being more common causes for revision surgery²³. Evaluation of the National Joint Registry of England and Wales from 2003 to 2010 determined that 12.1% of revisions were for fracture²⁴. Other international registries support the AOANJRR data concerning revision rates and reasons for revision. The 2018 Norwegian Arthroplasty Register reports fracture being the cause of 17.4% of all revisions⁹. Revision for fracture in the Swedish Hip Arthroplasty Register represents 9.1% of all revisions⁸ and Sweden reports re-operation as well as revision by a patient-based data linking process. PFF is the second most common reason for re-operation (35%) with infection being the most common (45.6%)⁸.

Consistent with our findings, other studies have shown that minor trauma and low energy falls are the main reason for a patient sustaining a fracture around a femoral stem^{15, 21, 25-27}. It is therefore unsurprising that the main risk factor for sustaining a PFF is age^{17, 26-28}. The age and gender distribution in our cohort was similar in proportion to other studies²⁷⁻³¹. It is postulated that females have a higher incidence of fracture due to lower bone mineral density²⁷. The incidence of surgically treated PFF in an analysis of 1751 primary hip prostheses was highest when the patient was 80 years or older³⁰. Cook *et al.* (2008) noted that the age at the time of the index procedure was a risk factor for PFF with a patient 70 years or older being 2.9 times more likely to sustain a PFF compared to patients less than 70 years old and likewise those 80 years or older were 4.4 times more likely than patients less than 80¹⁷. Revision is also a risk factor for PFF²⁷ with patients being 5 to 6 times more likely to need further revision compared to the index procedure³².

Biologic implant fixation has been implicated in the risk of PFF as well. Uncemented femoral stems increase the risk intraoperative fracture due to canal broaching or insertion of the stem^{21, 27, 33}. Moreover, osteolysis caused by stress shielding of press-fit fixation is thought to contribute to the occurrence of PFF²⁷. In a 10-year cohort study of 14065 primary hip replacements at one hospital, Singh *et al.* (2013) determined cemented implants were associated with a 30% lower risk of fracture²⁸. It is recommended that cemented femoral stems be considered for elderly arthroplasty patients as a strategy to reduce the burden of PFF³⁴.

In their retrospective analysis, Zuurmond *et al.* (2010) note that 32% of all PFF needing operative intervention had subsequent surgery post revision to manage complications³⁵. The one year mortality ranges between 11 and 34%³⁵⁻³⁹, with a higher mortality in the first 30 days³⁶ and up to 2.6% of all surgically managed PFF during their in hospital stay³¹. When compared to the index procedure and matched for age and gender, the 1-year mortality is significantly higher than the primary operation³⁸.

This study had a number of limitations. The total number of PFF determined by the study is an underestimate given it only detected patients admitted to hospital and does not factor those assessed in the emergency department, treated non-operatively and not admitted, nor does it include patients who did not present to hospital. However, we believe that this would likely be a very small number of patients, as all PFF affect mobility in this elderly population, making hospital admission likely. The study also reflects practice in the three hospitals included and may not be generalisable to other institutions. The detection of the true number of PFF could be improved by a patient-based data linking process, as occurs in Sweden⁸.

Australia's aging population and obesity will see a projected rise in the rate of primary hip arthroplasty to 150 per 100 000 population by 2030 compared to 129 per 100 000 in 2013⁴⁰. Currently, 15% of Australia's population are older than 65 which is set to increase to 18% by 2027⁴¹. Revision surgery for PFF is now the most common long-term reason for revision surgery in THA using modern bearing surfaces due to a decrease in the incidence of revision for loosening and wear of the prosthesis. These factors suggest that the incidence of PFF will continue to rise in coming decades.

Our study found that the overall rate of surgery for PFF is approximately twice the rate of surgery that involves revising the femoral component. We believe this study represents a better estimate of the overall burden of PFF than relying on the rate when a femoral component is revised.

4. Disclosure statement

Each author certifies that he has no commercial associations nor has received any financial benefit that might pose a conflict of interest in connection with the submitted article. No research scholarship/funding was received for this project.

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6. Supporting Information

Table S1. ICD-10 coded diagnoses used to extract discharge records.

7. Tables

Table 1. Patient demographics (n=200).

Demographic		
Mean Age (SD)		82.4 (9.5)
Gender	Male	76 (38.0%)
	Female	124 (62.0%)
Hospital	Liverpool	73 (36.5%)
	St George	51 (25.5%)
	The Sutherland Hospital	76 (38.0%)
Primary Prosthesis	Total Hip Arthroplasty (THA)	168 (84.0%)
	Hemiarthroplasty (HA)	32 (16.0%)
Implant Fixation	Cementless	103 (51.5%)
	Cemented	97 (48.5%)
Mechanism	Fall < 1m	181(90.5%)
	Fall > 1m	1(0.5%)
	Motor Vehicle Accident	2(1.0%)
	Atraumatic	4 (2.0%)
	Pathological process	1 (0.5%)
	Unclear/unknown	11 (5.5%)
Average LOS (days)	All PFF	16.7
	All revisions	18.9
	Revision alone	14.0
	Revision with internal fixation	19.8
	Internal fixation alone	17.4
	Non-operative	13.1

Table 2. Treatment of PFF by Vancouver classification.

Vancouver	Treatment				Total
	Non-operative	Internal Fixation	Revision Alone	Revision with Internal Fixation	
AG	42 (85.7%)	4 (8.2%)	0	3 (6.1%)	49
AL	0	0	0	2 (100%)	2
B	14 (11.2%)	49 (39.2%)	10 (8.0%)	52 (41.6%)	125
C	1 (4.2%)	23 (95.8%)	0	0	24

Table 3. The proportion of femoral stems revised by primary implant fixation.

Implant Fixation	Revised (%)
Cementless	44 (65.7)
Cemented	23 (34.3)