



Risk factors for early readmission due to surgical complications after treatment of proximal femoral fractures – A Finnish National Database study of 68,800 patients

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ABSTRACT

Introduction: Hip fracture surgery is associated with a considerable amount medical and surgical complications, which adversely impacts the patient's outcome and/or increases costs. We evaluated what risk factors were associated with the occurrence of early readmission due to surgical complications after hip fracture surgery.

Material and methods: A nationwide database with 68,800 hip fracture patients treated between 1999 and 2011 was studied to uncover the association of readmissions with co-morbidities, fracture types, different hospital types and treatment methods using the Cox proportional hazards model.

Results: Early readmission within three months due to hip fracture surgery complications occurred at a rate of 4.6%. Increased occurrence of readmission was found among patients with: heavy alcoholism (HR 1.38; 95% CI: 1.23–1.53); Parkinson's disease (PD; HR 1.22; 95% CI: 1.05–1.42); pre-existing osteoarthritis (HR 2.02; 95% CI: 1.83–2.23); rheumatic disease (HR 1.44; 95% CI: 1.27–1.65); as well as those with a fracture of the femur neck, depression, presence of a psychotic disorder, an operative delay of at least three days, or previous treatment with total hip arthroplasty.

Conclusion: Our results indicate that there are several factors associated with an increased risk of early readmission. We suggest that in the presence of these factors, the surgical treatment method and postoperative protocol should be carefully planned and performed.

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Introduction

Hip fractures constitute a large portion of services rendered at a typical hospital [1]. According to the Finnish Hospital Discharge Register (FHDR), the annual occurrence of new hip fractures is approximately 7000 per year in a population of 5.4 million [2]. Worldwide, the annual average hip fracture incidence varies between 150–250 fractures per 100,000 population [3]. Although age-standardized incidence of hip fractures seems to decline in industrialized countries, an aging population will ensure increasing numbers of these fractures in the coming years [4,5].

Hip fracture patients often suffer from medical and surgical complications [6–8]. Although medical complications are more frequent, surgical complications like deep wound infections, fixation failures or dislocations of hip arthroplasty often lead to further surgical interventions which more than doubles the cost of treatment. Along with increased costs, the occurrence of a surgical complication adversely affects the outcome for a hip fracture patient [9–11]. It is therefore important to find ways to avoid these complications in order to lessen the burden on the healthcare system and our patients. There is some data from single-center prospective studies reporting the incidence of complications after hip fracture surgery [12–16]. In addition, reoperations after hip hemiarthroplasties have been reported from the Norwegian and Swedish arthroplasty registries [17,18]. There are also reports concerning the overall re-admission rate not focusing on the surgical complications [19].

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The primary aim in this study was to quantify, from a national database, the occurrence of early surgical complications leading to readmission and to report the co-morbidities they would be associated with. The secondary aim was to find whether differences in the occurrence of complications between different treatment methods or fracture types existed.

Patients and methods

The data were extracted from the PERformance, Effectiveness and Cost of Treatment episodes (PERFECT) hip fracture database [20–23]. For the purposes of this study, 68,800 over 50-year-old patients admitted in Finland for their first proximal femoral fracture from 1.1.1999 to 31.12.2011 were identified using the 10th revision of the WHO International Classification of Diseases (ICD-10) diagnostic codes S72.0, S72.1, S72.2 and the Finnish version of the Nordic Medico-Statistical Committee Classifications' Procedural Codes, NFB10-50, NFJ50, NFJ52 or NFJ54.

Data on co-morbidities, use of residential care and deaths for this population were extracted from the Finnish Health and Social Welfare Care Register, reimbursement registries of the Social Insurance Institution and from the National Causes of Death Statistics, using the unique personal identification number for each patient [21]. Records in these registries include data such as patient and provider ID-numbers, age, sex, area codes, diagnosis and operation codes, as well as dates of admission, operation, and discharge (or death). The validity of the Finnish registry-data for hip fractures has been found to be very good [24].

For the purposes of this study, we defined an early readmission for surgical complication as one occurring within three months from index hip fracture operation, that was associated with a ICD-10 diagnostic code of: M96.6 (Fracture of bone following insertion of orthopedic implant, joint prosthesis, or bone plate); T81.0 (Hemorrhage and hematoma complicating a procedure); T81.4 (Infection following a procedure); or T84 (Complications of internal orthopedic prosthetic devices, implants and grafts).

In order to target the secondary aim of this study, fractures of neck of femur (S72.0), pertrochanteric fractures (S72.1) and subtrochanteric fractures (S72.2) were studied separately. Various treatment methods were divided into partial prosthetic replacement of hip joint (NFB10-20), total prosthetic replacement of hip joint (NFB30-50), screw fixation of neck of femur (NFJ50), fixation of proximal femur with plate and screws (NFJ52) and intramedullary nailing (NFJ54). To control for differences in the occurrence of complications between hospital types, hospitals were divided into four categories: university hospitals; central hospitals treating more than 200 hip fractures per year; central hospitals treating less than 200 hip fractures per year; and other hospitals (usually small regional hospitals).

Statistical analysis

The occurrence of complications was modelled using the Cox proportional hazards model. Follow-up time was three months from the operation day, until complication, or death, whichever occurred first. Observations terminating in death or the end of follow-up time were considered censored. Factors adjusted in the analyses included age, sex, co-morbidities, residential status at baseline and an operation wait time of more than two days in-hospital. Clustering of hospitals was also taken into account. In addition, the year of operation and hospital type was adjusted for using stratification, allowing the use of a different baseline hazard within the model. Data pre-processing and analyses were performed with R-3.2.2 and extension packages Survo R 0.6.20 and survival 2.38-3. A p-value of less than 0.05 was considered statistically significant.

Ethics

Ethics approval was obtained from the National Institute for Health and Welfare for this study (THL TuET §138/2010).

Results

Using the inclusion criteria, we identified 42,541 femoral neck fractures, 24,983 pertrochanteric fractures and 5276 subtrochanteric fractures treated surgically in Finland. The total annual occurrence of first hip fractures increased from 5131 to 5462 from 1999 to 2011; however, there was no change in relative amounts of fracture types during that time (Fig. 1). The characteristics of the study population are presented in Table 1.

Various surgical methods were utilized in the treatment of proximal femoral fractures (Fig. 2). The use of an intramedullary nail increased during the study period while use of plate and screws decreased. The use of arthroplasty (both hemi- and total arthroplasty) also became more popular at the expense of screw fixation.

The relative risks for early readmission due to surgical complication were studied in different hospital types. Risk was found to be 0.80 (0.73–0.88, $p < 0.0001$) in central hospitals treating more than 200 hip fracture patients a year and 0.96 (0.87–1.06, $p = 0.445$) in central hospitals treating 200 or less hip fracture patients a year when compared to university hospitals. Therefore, we adjusted for hospital type for the following comparisons.

Specific occurrence of readmissions for surgical complications over the study period according to fracture type is illustrated in Fig. 3. Occurrence of surgical complications remained less frequent among pertrochanteric fractures (3.1%) than subtrochanteric fractures (4.9%) or fractures of the neck of the femur (5.4%). The occurrence for infections was 1.4%, 2.1%, and 1.7%, respectively.

Differences in the occurrence of early surgical complications according to surgical method in the initial hip fracture operation were noted as well (Fig. 4). The arthroplasties – in particular total hip replacement (THR) – were associated with more surgical complications in the early postoperative period after hip fracture surgery.

In the patients treated with cannulated screws, re-fracture around the implant was relatively more common complication than in the patients treated with other methods (Table 2). Also, postoperative hemorrhage comprised a larger proportion of

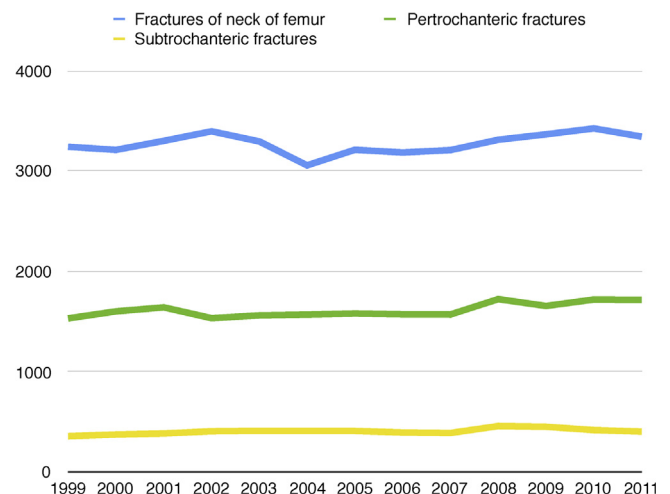


Fig. 1. The annual occurrence of hip fracture types in Finland during study period in over 50-years old patients (first hip fractures).

Table 1
Background information on the patients, including occurrence of comorbidities and fracture types.

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Background characteristics		
Age (mean, years)	78	
Men, %	30,4	20 941
Admitted from long-term care, %	15,8	10 865
Patients using calcium and vitamin D, %	18,6	12 820
Patients using antiosteoporotic agents, %	18,6	12 815
Heart disease, %	37,4	25 762
Alcoholism, %	4,2	2 886
Cancer, %	12,5	8 615
Chronic obstructive pulmonary disease, %	13,1	9 004
Dementia, %	17,5	12 095
Depression, %	22,7	15 584
Parkinson's disease, %	4,9	3 384
Psychotic mental disorders, %	11,9	8 157
Rheumatoid disease, %	6,7	4 585
Cerebrovascular disease, %	15,8	10 889
Fracture types		
Fracture of neck of femur	61,8	42 541
Pertrochanteric fracture	30,5	20 983
Subtrochanteric fracture	7,7	5 276

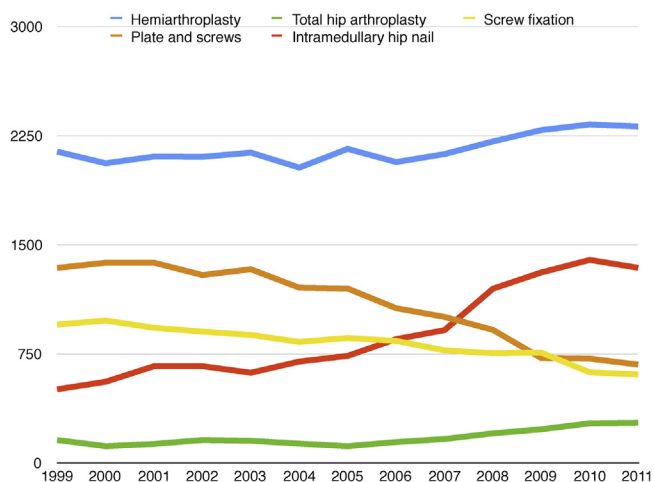


Fig. 2. The annual use of different surgical methods in the treatment of hip fractures in Finland 1999–2011 (first hip fractures in over 50-year-old patients).

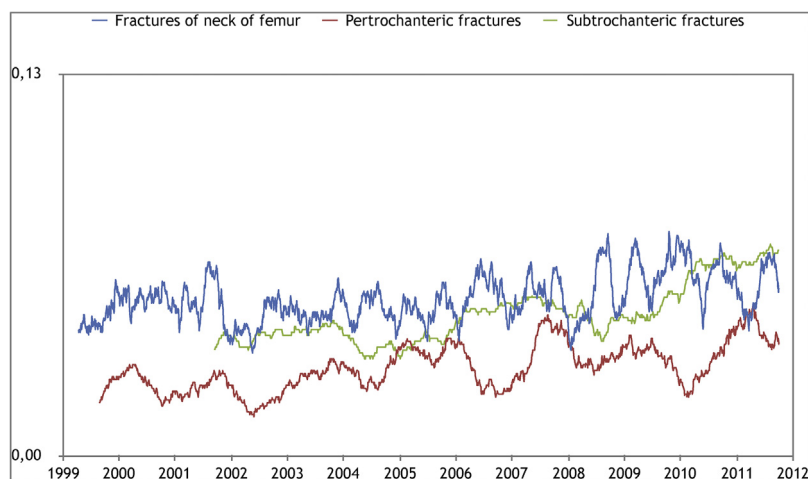


Fig. 3. The occurrence of early re-admissions due to surgical complications according to surgical method used in fracture surgery.

complications in patients treated with osteosynthetic methods than patients treated with arthroplasty.

Association of early surgical complications with various comorbidities in hip fracture patients was noted as well. Alcoholism and Parkinson's disease (PD) were associated with increased risk of complications (Fig. 5). Similarly, depression, psychotic disorders, rheumatoid diseases, pre-existing osteoarthritis and an operative delay of at least three days were linked to increased complication risk. The operative delay was also associated with an increased risk for surgical complications (Table 3).

Discussion

To our knowledge, this study is the first nationwide register-based hip fracture survey with a focus on early surgical complications after a hip fracture and its' treatment. Our estimate of the occurrence of early readmissions for surgical complications is in line with published results from single-center studies [7,9–11].

Early readmission within 90 days for surgical complications after hip fracture was chosen as the primary outcome, as surgical complications have a major impact on the results of hip fracture care due to associated increases in cost and mortality [10]. The outcome was deemed reliable, since readmission is a well-defined event. In addition, the timeframe limits the chance of the event being due to a contralateral fracture. We are aware that our outcome measure does not include less serious complications (i.e. superficial wound problems) not leading to a readmission.

Co-morbidities are linked to higher mortality after a hip fracture [25–27]. Less is known whether co-morbidities could increase the risk for surgical complications after a hip fracture. We were able to detect a higher risk for an early readmission for surgical complication among patients with alcohol abuse, Parkinson's disease (PD), rheumatoid disorders and existing osteoarthritis, but not all co-morbidities carried such a risk. One such comorbidity is diabetes, which was not associated in our study with a higher occurrence of readmission for surgical complications. This finding has been made also earlier in one study [28].

We were able to show an association between alcohol abuse and readmission for surgical complications after hip fracture. This result is supported by the study of Faroug et al., where heavy alcohol abuse was linked to hip fracture complications [29]. The relationship of excessive preoperative alcohol consumption with surgical complications in general is known [30]. Concerning hip fracture patients, it has been detected earlier that mortality is

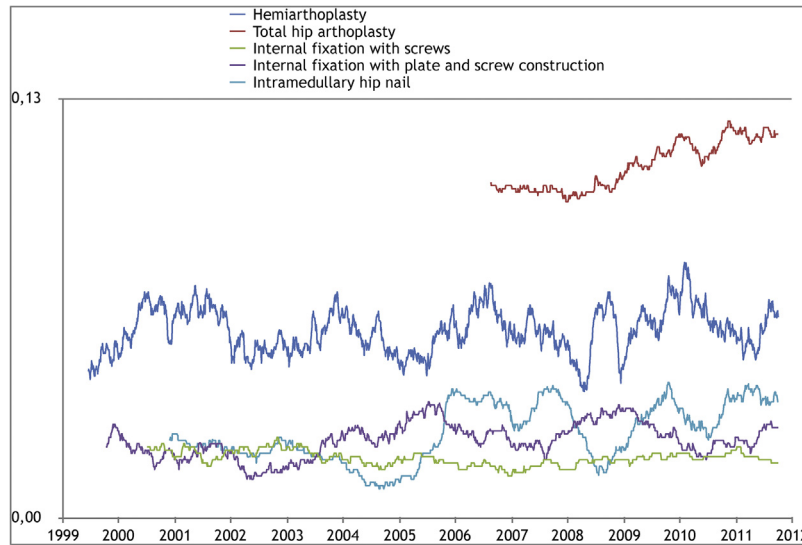


Fig. 4. The occurrence of early re-admissions due to surgical complications according to surgical method used in fracture surgery.

Table 2
The distribution of complication types according to type of operative procedure used.

	Fixation with cannulated screws (N = 511)	Sliding hip screw and side plate (N = 346)	Intramedullary nail (N = 328)	Hemiarthroplasty (N = 1641)	Total hip arthroplasty (N = 236)	Other or unspecified procedure (N = 136)	Combined (N = 3198)
Re-fracture around the implant (%)	10	2,1	2,1	2,3	2,5	6,6	3,7
Postoperative hemorrhage (%)	7,2	16	16	6,1	3,4	5,1	8,1
Postoperative infection (%)	28	47	58	36	20	35	37
Other (%)	55	35	25	56	74	53	51

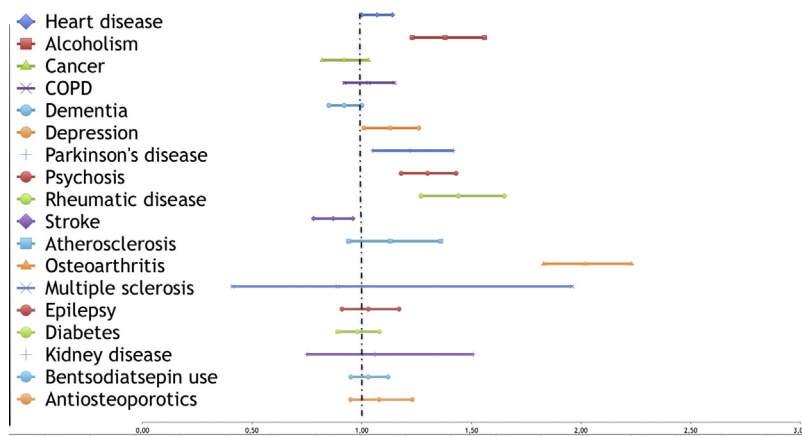


Fig. 5. Relative risks for an early readmission due to a surgical complication in patients with above-mentioned, pre-existing comorbidities.

elevated in alcoholic patients [31]. It also seems that use of THR for hip fracture in alcoholic patients carries a high risk for revision surgery [32].

We found that patients with PD have more complications after hip fracture treatment. This is a novel finding. It has been found that patients with PD recover more slowly from a hip fracture, but in previous studies heightened risk for surgical complications has not been noted [33–36]. However, these single-center studies included relatively low numbers of PD patients. It is thus possible that they were underpowered and unable to detect the differences

in surgical complications among these patients. In the setting of an elective THR, it is known that PD patients are at risk for dislocation [37].

We observed an increased risk for early readmission for surgical complications when THR was used for treatment of hip fractures. THR has been studied and found to be a reliable treatment method for femoral neck fractures in randomised prospective trials [38]. It has also been suggested that THR would be more cost-effective method when compared to hemiarthroplasty for the treatment of femoral neck fractures [39]. Neither of these studies report any

Table 3

The occurrence of readmission due to surgical complication within first three months after a hip fracture operation. * HR, hazard ratio; HRLCI, hazard ratio lower confidence interval; HRUCI, hazard ratio upper confidence interval.

	Relative risk for readmission due to surgical complication within three months		p-value
	HR	HRLCI – HRUCI	
Men	1,00		
Women	0,91	0,85–0,97	0,004
Fracture of neck of femur	1,00		
Pertrochanteric fracture	0,56	0,52–0,61	<0,0001
Subtrochanteric fracture	0,85	0,72–0,99	0,039
Operative delay <3 days	1,00		
Operative delay ≥3 days	1,20	1,04–1,38	0,013

significant increase in early complications after THR. The difference between these findings and our results may be due to study design. Prospective trials usually have a certain amount of exclusion criteria in order to obtain a high internal validity. However, when their results are extrapolated to clinical practice, the treated population tends to be more heterogeneous. Similarly, in clinical trials surgeons performing the operations are often dedicated to a specific field and procedure. It may be that THR, as a more challenging procedure than hemiarthroplasty, is more prone to complications when it is applied by less experienced surgeons on a more heterogeneous patient population.

We found that readmissions were less frequent among patients treated in non-university central hospitals when compared to university hospitals which treat the highest volume of hip fractures. When we studied non-university hospitals with more precision, we found that hospitals treating more than 200 hip fracture patients performed better than the units with lower volume. Laarhoven et al. have detected that level II trauma centers with high volume of hip fractures may be superior in performing hip fracture surgery [40]. This is in concordance with our results since most non-university hospitals treating hip fracture patients in Finland can be classified as level II trauma centers. Our data does not support the centralization of hip fracture patients to level I trauma centers.

The strength of our study is the inclusion of all over 50-year old patients treated for their first proximal femoral fracture in Finland during 1999–2011. Consequently, our results give a picture of how the health-care system performs in everyday practice. The PERFECT database used in this study is based on routinely collected data from Finnish healthcare registers [20–22]. The validity of the data from these registers such as FHDR, Health Care Register and the Causes of Death Register have been compared to prospectively collected hip fracture audit data [24]. The validity of the FHDR alone has been assessed in over 30 additional studies where positive predictive values and completeness have been found to be over 90% [41]. The prescription database data, which forms a part of our assessment on co-morbidities, has been found to be in high concordance with self-reported medication [42]. Based on the above, it seems that the Finnish register data is valid enough for a performance assessment of hip fracture treatment, yielding data that supplements the prospective trials. Another strength in our register-data is that all patients are followed through the patient pathway, and are not limited to the primary treating hospital.

The limitations of this study are inherent to register studies, such as reliance on the accurate use of diagnostic and procedural codes used during normal clinical practice. We do not consider the retrospective design as a major limitation because all patients who had surgery for hip fracture were followed, and selection as a source of bias is not probable. The primary outcome, an early readmission for a surgical complication, is not equivalent for all

surgical complications. The PERFECT data does not identify early reoperations occurring during the primary treatment period in the hospital. This period, however, is usually relatively short in Finland and patients are often transferred to a rehabilitation unit or health center ward on the second or third postoperative day. Thus, we believe that most often surgical complications are treated during a second readmission in our healthcare system. Additionally, we find early readmissions to be an important outcome since they represent an unexpected occurrence in the patient pathway and should be a target for appropriate measures. While our estimate of early complications may not be an absolute number of all surgical complications, it is a suitable outcome for comparisons and identification of risk factors for complications.

Conclusions

In conclusion, we detected an overall rate of 4.6% for early readmissions for surgical complications after hip fracture surgery. Based on our results, extra precaution and awareness should be used when treating patients with alcohol abuse, PD, rheumatoid disorders or pre-existing osteoarthritis, as these patients may be more prone in acquiring surgical complications after hip fracture surgery. The use of THR for hip fractures warrants further surveillance in registries as it may be associated with increased early complications compared to what has been suggested in prospective trials. Finally, we find our results support a creation of a hip fracture database at the national level in most countries.

Conflict of interest statement

We declare that we do not have any conflicts of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.injury.2018.10.030>.

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