



Research Paper

Prosthesis or osteosynthesis for the treatment of a pathological hip fracture? A nationwide registry-based cohort study



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ABSTRACT

Aims: How endoprosthetic replacement compares to osteosynthesis in the treatment of pathologic hip fractures as far as functional outcome and use of healthcare resources is concerned remains largely unknown. We aimed to investigate this in a nationwide registry.

Methods: We analyzed the functional outcome after surgery for a pathological fracture of the hip in terms of post-operative pain and ambulatory capacity. The preferred surgical method depending on the level of the treating unit was also examined. Furthermore, we documented the length of hospital stay and the patterns of discharge and compared them between these two methods.

Results: Patients operated with an endoprosthesis reported significantly lower pain at follow-up. Both methods (endoprosthetic replacement and osteosynthesis) were equally effective in restoring the ambulatory capacity and demanded a similar length of stay in hospital. Orthopaedic surgeons working in hospitals with dedicated sarcoma teams were more likely to use a prosthesis rather than osteosynthesis, when compared to surgeons working at other university hospitals or emergency hospitals.

Conclusion: Endoprosthetic replacement results in a better functional outcome in terms of post-operative pain without consuming more healthcare resources. Orthopaedic surgeons working in hospitals with sarcoma centers are more likely to use prostheses as compared to surgeons working at hospitals where dedicated musculoskeletal oncology teams are not available.

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1. Introduction

The most frequent site for symptomatic metastatic bone disease (MBD) of the appendicular skeleton is the proximal femur and hip. A pathological hip fracture is by rule treated surgically, in order to restore the patient's ambulatory capacity and reduce pain[1]. There are two principal treatment methods for a pathological hip fracture: osteosynthesis and endoprosthetic reconstruction (hip replacement surgery). The former relies on mechanical fixation of the bone fragments with an implant such as an intramedullary rod, pins/screws or a plate-and-screw design. The latter entails resection of the humeral head and possibly other parts of the bone involved by the tumor, and replacement with a prosthesis that is usually attached to the remaining femur with bone cement.

Prostheses have been associated with lower risk for revision surgery to implant failure, since they are more able to withstand

the mechanical loads over time[2–5]. Osteosynthesis relies on implants designed for conventional, traumatic fractures, which normally heal over time. Pathological fractures on the other hand rarely heal, since the local invasion by tumor cells inhibits the bone healing process[6]. Many authorities thus recommend the preferential use of prostheses in cases of pathological hip fractures, although others have questioned these findings[7–10]. However, other important parameters regarding the outcome of surgery, such as the functional outcome of the patient and the use of healthcare resources, have not been studied to the same extent as implant failure rate when comparing different treatment methods. These parameters should also be considered in the treatment decision since they affect the patients' quality of life and the sustainability of the healthcare system in view of the increasing burden of MBD[11].

To answer these questions, we conducted a nationwide registry study to investigate the outcome of surgical treatment for pathological fractures of the hip and analyzed the functional outcome of surgery and the use of healthcare resources. The focus was whether endoprosthetic replacement is superior to osteosynthesis

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in these aspects. Furthermore, we explored the patterns of surgical treatment in hospitals of different levels (tertiary sarcoma/musculoskeletal cancer centers, university hospitals and emergency hospitals).

2. Patients and methods

Data for this nationwide cohort study were extracted from the Swedish Registry for Hip Fracture Patients and Treatment (RIKSHÖFT). 47 of the 52 orthopaedic clinics in Sweden report voluntarily to RIKSHÖFT and the coverage rate exceeded 80% during the years 2014–2018. Data is collected by nurses or contact secretaries, who transfer data into a web-based system (Comportosystem) at operation and at follow-up 4 months after surgery. Information regarding date of death was transferred from Statistics Sweden using the personal identification number assigned to all individuals living in Sweden. The study to the Helsinki Declaration and was approved by the Regional Ethics Committee of Stockholm (DNr: 2017/1088–31).

2.1. Inclusion and exclusion criteria

The flowchart of the study cohort is shown in Fig. 1. Patients with pathological hip fracture due to metastasis admitted to hospital between the 1st of January 2014 and the 31st of December 2018 were included. Patients with primary sarcoma, bone cyst or Paget's disease were excluded to create a homogeneous study material. Double treatment cases were also excluded.

2.2. Recorded variables and sub-group analysis

Relevant recorded variables were: gender, age at surgery (years), living condition prior to hospital admission (living in own home, hospice/palliative care or other hospital), type of fracture (sub-grouped in: cervical, intertrochanteric and sub-trochanteric) and surgical method used (sub-grouped in: hemiarthroplasty, total hip replacement, osteosynthesis with pins/screws, osteosynthesis with plate/screws or sliding hip screw and osteosynthesis with intramedullary rod), treating hospital (sub-grouped in: university hospital with dedicated sarcoma center, referred also as sarcoma centers, other university hospitals and emergency hospitals), ASA grade prior to surgery as an index of comorbidity, time from admittance to surgery (in hours), length of hospital stay (days) and pattern of discharge (to home, hospice/palliative care, other hospital), reported pain (sub-grouped in: severe, moderate/activity and minor/none) and ambulatory capacity (independent outdoors, assisted outdoors, independent indoors, assisted indoors) at 4-month follow up, death and death date.

2.3. Statistics

Statistical calculations were performed in SPSS 25. Descriptive statistics are presented with number(s), proportions (%), range and median or mean values with standard deviations. Bars represent 95% confidence intervals. Comparisons of categorical data were done with the χ^2 test. Survival analysis was done using the Kaplan – Meier method, with the log-rank test to evaluate differences between groups. Mean patient survival is presented in months with 95% confidence intervals shown in parentheses. A p-value below 0.05 was defined as statistically significant.

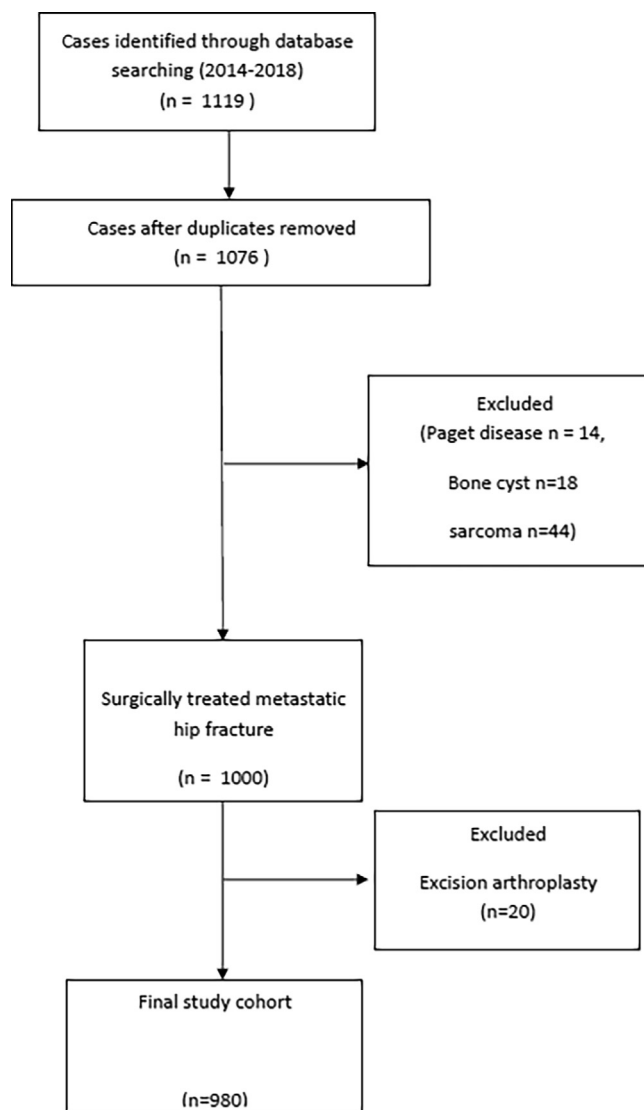


Fig. 1. Flowchart analysis of the cases included in the study.

3. Results

3.1. Oncological characteristics of the cohort

The cohort consisted of 980 patients and its main characteristics are presented in Table 1. 104 patients were operated at hospitals with dedicated sarcoma teams, 150 in other university-level hospitals and 726 in emergency hospitals.

Patients operated in sarcoma centers had higher comorbidity grade ($p = 0.024$), since 82% were ASA 3 and 4 class, as compared to 66% of patients in other university-level hospitals and 70% of patients in emergency hospitals. Patients operated in sarcoma centers also had inferior oncologic outcome ($p = 0.005$), since their overall survival was only 16(12–20) months, as compared to the ones operated in other university hospitals and emergency hospitals, who had an overall survival of 21(17–26) months and 25 (23–27) months respectively. Mean time from hospital admittance to surgery differed also among healthcare providers, with sarcoma centers and other university hospitals having a longer time from fracture to surgery (44 and 41 h respectively) as compared to other emergency hospitals (32 h) ($p = 0.005$).

Table 1
Description of the study cohort.

Number of patients	Total	Prosthesis	Osteosynthesis
	980	508	472
Gender			P = 0.098
Men/Women	485/ 495	262/246	223/249
Age			P = 0.062
Median/Mean Range	78/77 32–104	76/77 32–104	77/79 32–100
Type of fracture			P < 0.001
Cervical, non-displaced	91	37	54
Cervical, displaced	432	395	37
Basocervical	38	17	21
Intertrochanteric, 2-part	134	20	114
Intertrochanteric, multifragmentary	91	11	80
Subtrochanteric	194	28	166
Admitted from			P < 0.001
Home	708	352	356
Nursing home/hospice	125	57	76
Emergency hospital	131	96	35
Other	6	2	4
Missing	2		
Walking aids prior to fracture			P = 0.267
Independent	367	188	179
Walking stick/cane	155	85	70
Walking frame/trolley	372	199	173
Wheelchair/bedridden	65	26	39
Missing	21		
Discharged to			P = 0.065
Home	399	209	190
Nursing home/hospice	348	170	178
Other hospital	178	104	74
Dead	49	22	27
Other	5	2	3
Missing	2		
Status at last follow-up			P = 0.085
Dead	672	363	309
Alive	308	145	163

3.2. Patterns of treatment of pathological hip fractures

Osteosynthesis was performed in 472 patients, in 85 of them with pins/screws, in 96 with plate and screws and in 291 with intramedullary rods. Endoprosthetic replacement was performed in 508 patients (hemiarthroplasty in 295 and total hip replacement in 213). Patients treated at sarcoma centers were more likely to be operated with a prosthesis rather than osteosynthesis (Table 2a). When data were separately analyzed for the 3 main types of pathological hip fractures (cervical, intertrochanteric and subtrochanteric), it became evident that surgeons working in sarcoma centers were more likely to use a prosthesis even for intertrochanteric and subtrochanteric fractures. The pattern of surgical treatment between university hospitals and other emergency hospitals was similar (Table 2b).

3.3. Correlation of treatment method with the functional outcome

The functional outcome was assessed 4 months after surgery, and both the pain levels as well as the patients' ambulatory

Table 2a
Patterns of surgical treatment of pathological hip fractures in different hospitals across Sweden.

Hospital level	Prosthesis	Osteosynthesis	P < 0.001
Sarcoma Center	86	19	
University Hospital	70	80	
Emergency Hospital	353	373	
Total	508	472	

Table 2b
Patterns of surgical treatment of pathological hip fractures depending on the anatomical location.

Sarcoma Centers			
	Prosthesis	Osteosynthesis	P < 0.001
Cervical fracture	55	1	
Trochanteric fracture	14	4	
Subtrochanteric fracture	16	14	
Total	85	19	
University Hospitals and Emergency Hospitals			
	Prosthesis	Osteosynthesis	
Cervical fracture	377	90	
Trochanteric fracture	34	211	
Subtrochanteric fracture	12	152	
Total	423	453	

capacity were reported (Table 3). Data were available for 272 patients since there were not any recorded data for 249 patients and 359 patients were dead at this time-point. Patients operated with a prosthesis reported significantly lower pain than patients operated with osteosynthesis (p = 0.004) (Table 3).

After subgroup analysis for the 3 principal fracture patterns (cervical, intertrochanteric and subtrochanteric), this effect was attributed to the lower level of reported pain of patients with cervical fractures operated with a prosthesis, as compared to the ones operated with pins/screws (p = 0.004). The difference in reported pain among patients with intertrochanteric and subtrochanteric fractures, who were operated with either a prosthesis or with osteosynthesis, did not reach statistical significance (p = 0.800 and p = 0.371 for intertrochanteric and subtrochanteric fractures respectively).

In the subgroup of patients operated with a prosthesis, pain 4 months after surgery did not differ significantly between the ones who had a total hip arthroplasty and the ones who had a hemiarthroplasty (p = 0.421). In the subgroup of patients operated with osteosynthesis, reported pain was similar among patients who underwent fixation of the fracture with a dynamic screw and plate construct, as compared to the ones operated with pins/screws or intramedullary nails (p = 0.054).

Regarding ambulation, both treatment methods (prosthesis and osteosynthesis) were equally efficient in restoring the ambulatory capacity, as shown in Table 3 (p = 0.928). As shown in the same Table, there was no significant difference in the use of walking aids between the two principal groups at follow-up (p = 0.853).

Table 3
Functional status of the patients 4 months after surgical treatment.

Reported pain	Prosthesis	Osteosynthesis	P = 0.004
Severe	6	10	
Moderate/activity-correlated	43	63	
Minor/none	134	94	
Unable to answer	14	8	
Total	197	175	
Ambulatory capacity			P = 0.928
Independent outdoors	100	83	
Assisted, outdoors	22	18	
Independent, indoors	35	34	
Assisted, indoors	21	19	
Non-ambulatory	19	21	
Total	197	175	
Walking aids			P = 0.853
None	55	44	
Walking stick/cane	33	26	
Walking frame/trolley	88	80	
Wheelchair/bed-ridden	21	25	
Total	197	175	

3.4. Correlation of treatment methods to the use of healthcare resources

Patients were admitted to hospital for a mean of 7 days (median 6, range 1–58). The time period of the patient remaining in hospital was similar between patients operated with a prosthesis and the ones operated with osteosynthesis ($p = 0.497$), as well as between levels of the treating units (sarcoma centers, university hospitals, emergency hospitals) ($p = 0.942$). Patients previously living in their own home had similar mean length of stay in hospital (7 ± 13 days) as the ones coming from hospice/nursery homes (6 ± 3 days) and the ones already admitted to hospital (7 ± 6 days).

Most patients were discharged to their own home: 53% of patients operated with a prosthesis and 49% of patients operated with osteosynthesis could be discharged back to their home, irrespective of treatment method and treatment center. At follow-up, 4 months after surgery, there was no significant difference between groups regarding the dwelling condition of the patients ($p = 0.903$).

4. Discussion

The principal finding of this nationwide registry study is that the use of endoprosthetic devices for the surgical treatment of pathological hip fracture is associated with a superior functional outcome in terms of pain alleviation as compared to osteosynthesis. This complements previous knowledge that prostheses have lower risk of failure, which was considered the primary reason why they were recommended as the implants of choice in the setting of pathological fracture surgery[2,3,5]. Prostheses are implants primarily used in the surgical replacement of degenerate joints and thus designed to function as load-bearing devices for long time periods, that exceed by far the expected survival of a patient with MBD[12]. Their longevity is thus not surprising, and their main mode of failure is the failure of the remaining bone stock due to tumor progression. Their superiority in terms of pain relief can possibly be attributed to the fact that they allow for a more stable reconstruction than osteosynthesis. The latter usually allows for some movement between fracture fragments, which is considered beneficial in the context of traumatic fractures, since it promotes bone healing[13]. In MBD, where the implant is only stabilizes the fracture and no significant healing is expected, this may prove a source of pain for the patient.

There is a very limited number of previous studies addressing the functional outcome of patients operated for pathological hips fractures: Guzik reported superior result in terms of pain relief in patients operated with a prosthesis, as compared to osteosynthesis, in a cohort of 122 patients, whereas Harvey *et al* and Meynard *et al* reported similar functional outcome in cohorts of 158 and 299 patients respectively[5,14]. Our data, from a comparatively large cohort with standardized follow-up, strongly support the superiority of endoprosthetic replacement in terms of pain relief. Regarding restoration of the ambulatory capacity the methods were directly comparable, corroborating the findings presented by Maynard *et al*.

The difference in functional outcome between osteosynthesis implants is probably the result of selection bias: it is likely that dynamic screw and plate devices were used in more stable, less displaced fractures, whereas intramedullary nails in unstable ones[15]. Pin/screw fixation usually results in poor biomechanical stability in MBD, whatever the fracture pattern. In our study functional results between hemiarthroplasty and total hip replacement were comparable, supporting the view that in MBD, where short-term functional results are of importance considering the short

patient survival, the use of hemiarthroplasty rather than total hip replacement is preferable in the majority of patients since it is associated with a lower risk for dislocation and shorter operative time[16,17]. This is contrary to the traumatic hip fracture scenario, where total hip arthroplasty is associated with better functional outcome[18]. Prognostication tools allow for choice of patients with MBD who are expected to have longer survival and thus benefit from total hip arthroplasty[19,20].

We acknowledge that our work has significant limitations, being a registry study, where data have inherent treatment bias or may be lacking for several patients or even incorporate errors during registration. Furthermore, a major shortcoming of the present dataset is that primary diagnosis is unknown, and this precludes analysis particular to each cancer type. Moreover, megaprotheses were not specifically coded in the dataset. Given these limitations, another principal observation in the present study is the compliance of healthcare providers to the generally accepted between orthopaedic oncology surgeons in Sweden recommendation of using endoprotheses rather than performing osteosynthesis in pathological hip fractures. A previous study in a international group of orthopaedic oncologists has highlighted the variation in the choice of surgical approach[21]. Our national registry data, from a country with a comparatively small population and a general consensus in treatment protocols between orthopaedic oncology surgeons, in addition show that the latter comply better than orthopaedic surgeons at university or emergency hospitals. The limited penetration of this knowledge among orthopaedic surgeons other than the ones working in centers routinely treating patients with MBD raises considerations regarding the way this information is conveyed to the orthopaedic surgeon community. It is also noteworthy that surgeons in sarcoma centers abide by this recommendation even though they apparently treat patients who are more frail and/or have more extensive disease, as shown by the comorbidity grading and overall survival, where a general orthopaedic surgeon may be even more tempted to restrain from hip replacement in order to avoid more extensive surgery and the use of bone cement. A potential pitfall in this deduction is that we are not aware of the technical difficulty of the cases treated in each hospital level and cannot exclude that surgically demanding cases with major loss of bone stock, thus not amenable to osteosynthesis, are further admitted to hospitals with dedicated orthopaedic oncologists. Differences in the time to surgery may reflect, apart from the availability of healthcare resources and the differential time to optimize each patient for surgery, the need to transport demanding cases to higher-level care.

We did not observe any significant differences in the use of healthcare resources or efficacy of return to community between the two treatment groups. Both methods resulted in equivalent hospital stay and comparable discharge patterns as well as status of social care at follow-up. We did not take implant costs into account since these differ significantly between manufacturers and institutions around the world. Noticeably, the mean period of hospital stay of one week is quite short compared to non-pathological fractures, and probably reflects the effective pathway of referral of these patients back to palliative care[22].

Our study strongly supports the use of endoprosthetic replacement instead of osteosynthesis in MBD of the hip, since it results in a less painful extremity without requiring additional health resources, a finding which complements the superiority of endoprosthetic replacement in terms of risk for implant failure and need of revision surgery. This recommendation appears to be preferentially implemented by specialized orthopaedic oncology surgeons and has not been adopted by general orthopaedic surgeons not routinely treating MBD.

CRediT authorship contribution statement

Panagiotis Tsagkosis: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Jessica Ehne:** Conceptualization, Formal analysis, Writing - review & editing. **Rikard Wedin:** Methodology, Validation, Writing - review & editing. **Margareta Hedström:** Resources, Supervision, Project administration, Funding acquisition, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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