

A retrospective analysis of bilateral fractures over sixteen years: localisation and variation in treatment of second hip fractures

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Abstract The aim of this study was the evaluation of contralateral hip fractures after a previous hip fracture. For this retrospective analysis patients were selected from the database of the LUMC, a teaching hospital in the south-west of the Netherlands. We analyzed all patients with a second fracture of a hip between 1992 and 2007. The exclusion criteria were high impact trauma and patients with diseases or medication known to have a negative effect on bone metabolism. A total of 1,604 hip fractures were identified. The possible predictive factors for the second fracture and descriptive statistics related to surgery (Hb and HT before and after the operation, total amount of intra- and postoperative blood loss, type of osteosynthesis, complications, time of death after the last fracture, time between arrival in the hospital and operation and hospital stay for both fractures) were recorded. A total of 32 second hip fractures were identified (2%) at a mean of 27.5 (SD 28.9) months after the initial hip fracture. The mean age at the first fracture was 77.2 years (SD 11.7), and 27 of 32 patients were female. Of these 32 patients (64 bilateral hip fractures), 32 fractures were intracapsular (1 femoral neck, 31 subcapital) and 32 were extracapsular fractures (6 subtrochanteric, 26 transtrochanteric). Although 24 of the 32 patients had identical first and second hip fractures, only eight out of 32 hips were treated with the same implants. There was a significant difference in Singh index between both hips at the time of the first fracture. There was also a significant difference in Singh index between the hip which was not fractured compared with its subsequent index when it was broken. All other studied patient and fracture

characteristics were not significantly different. In this population the percentage of second hip fractures was relatively low compared to other studies. The choice of implants in this study shows that implants were chosen randomly. Because there is a significant difference in the Singh index during first and second hip fracture, osteoporosis medication might help reduce the incidence of second hip fractures.

Introduction

The lifetime risk of hip fracture is 17.5% in women and 6.0% in men [1]. The complications of hip fracture include death, disability, long-term care needs and loss of social independency [2]. Following hip fracture surgery, there is a one-year mortality rate up to 36% over the subsequent year, half of the patients will be unable to walk without assistance, and half of them will require long-term domiciliary care thus prevention of a second hip fracture will improve quality of life [2–4]. Among the survivors of a first hip fracture, there is a high incidence, 5–20% [5, 6], of a second hip fracture. Half of all hip fracture patients will never recover to their pre-fracture functional capacity and 25% of these patients reside in a long-term care institution one year after sustaining a hip fracture [7]. Taking these facts into consideration, it is obvious that all our efforts should go towards preventing first and second hip fractures. Different strategies to prevent hip fractures and consequent hip fracture surgery have been introduced to reduce the incidence of a second hip fracture [8–10]. An alternative approach to prevention could be femoroplasty of the contralateral hip during the surgery of the first hip fracture [11, 12]. Recent results of cement and elastomer femoroplasty were published [11, 12]. Since femoroplasty with flexible

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elastomer is more likely to prevent intracapsular hip fractures, prediction of fracture localisation of the second hip fracture based on the first hip fracture is necessary. Observations in other studies already indicate symmetry in the two fracture localisations. Although there is a lot of data available on first hip fractures, less is known about patients with a second hip fracture. There is very little known about the symmetry in localisation of hip fractures, symmetry in implants, and patient-specific factors which differ between the first and second hip fracture. The aim of this study was to determine the prevalence of second hip fractures and to establish both the localisation of the fracture and the type of the implant used. We hypothesized that second hip fractures often occur in the same localisation as the first. Ultimately this could lead to establishing preventive measures.

Patients and methods

All patients with a proximal femur fracture and admitted to the Leiden University Medical Centre between 1992 and 2007 were included in this retrospective observational study. Patients were selected from two databases at the Leiden University Medical Centre: the financial administration database since January 1992 up to December 2007, and from 1999 to December 2007 the database of the surgical operative (OPERA) codes of proximal hip fractures from the departments of Orthopaedics and Traumatology / General Surgery. The second database was included in the search strategy to have a double-check with the financial administrative database.

Selection criteria for search strategy in both databases were patients with two or more surgical procedures of the proximal femur with either osteosynthesis or a (hemi) arthroplasty. The second criteria was that only patients older than 50 years of age were included as this is the cut-off age used by the WHO for an increased risk for low energy impact fractures. Patients who had a bilateral (both left and right) hip fracture during the 16-year follow-up period were identified. Exclusion criteria were high impact trauma and patients with diseases or medication known to have a negative effect on bone metabolism (i.e. corticosteroids). As the study was considered a form of good clinical practice with no extra involvement of patients, medical ethics approval was waived. The paper hospital charts as well as the hospitals electronic database (Mirador) were both used to collect the study variables. All radiographs of the bilateral hip fractures were scored as well. The variables scored were: age, gender, preoperative body weight, trauma mechanism, localisation of the fracture at the preoperative radiograph (intracapsular: subcapital, femoral neck; extracapsular: trochanteric, subtrochanteric), time between both proximal femur fractures, time between arrival

at the hospital and the surgical procedure, preoperative comorbidity classification (American Association of Anaesthesiologists [ASA]); type of treatment (i.e. type of implant), blood loss, pre- and postoperative haemoglobin (Hb) and haematocrit (Ht), length of hospital stay for each of the fractures, postoperative complications, time between death and last hip fracture. Furthermore, any osteoporosis medication (vitamin D, calcium and bisfosfonates) was scored at three time periods: before and after the first fracture, and after the second fracture. Finally, the radiographs (AP and lateral hip and pelvis) at the first fracture occurrence were assessed for the degree of osteoporosis (the Singh-index) [13]. The inter-observer variability was tested within two weeks (L.K.). In case of disagreement on the Singh index class a second observer (R.N.) was consulted. Surgery was performed by several surgeons, both staff surgeons as well as residents under supervision of the two earlier mentioned specialties. All data was entered in an access database, which was converted to an SPSS database for analysis. Statistical analysis was performed using SPSS version 16.0. Agreement for implant choice, if the localisation was the same for both fractures, was calculated using Cohen's kappa statistics. Differences in parametric variables were tested with the *t*-test. Differences between non-parametric variables like the Singh index and ASA-classification were tested with the Wilcoxon signed rank test.

Results

A total of 1,604 patients had hip surgery for a hip fracture between 1992 and December 2007. In this period 150 patients (9.4%) had two or more surgeries of the proximal femur. Of these 150 patients, 118 patients were excluded because of either high impact trauma, failing implants or diseases or medication (i.e. corticosteroids) known to have a negative effect on bone metabolism. Patients who had an arthroplasty for indications other than a fracture (i.e. osteoarthritis, metastasis) were also excluded. Thus, 64 bilateral fractures in 32 patients (2.0%) could be identified to have a proximal femoral fracture after low impact trauma. The mean age at the first fracture was 77 years (SD 11.7) and for the second fracture 80 years (SD 11.3) (Table 1). The mean time between the first and second fracture was 27.5 months (SD 28.9). Out of all the patients 27 were women, and five were men. Of the 32 patients 13 patients died during the follow-up period, with an average survival of 32 months after the last hip fracture. The Kaplan-Meier survival curve of the patients after the second hip fracture is shown in Fig. 1.

Of the 64 bilateral fractures 32 were intracapsular, and 32 were extracapsular. The second hip fracture was in the same locality as the first in the proximal femur in 24 of the

Table 1 Patients characteristics

Characteristic	Fracture 1	Fracture 2
Age (y)	Mean: 77.2 SD: 11.7 Missing: 0	Mean: 79.6 SD: 11.4 Missing: 0
Gender	Men: 5 Women: 27 Missing: 0	
Weight	Mean: 66 SD: 16 Missing: 3 Men - Mean: 67 - SD: 25 - Missing: 0 Women - Mean: 66 - SD: 14 - Missing: 3	Mean: 66 SD: 15 Missing: 5 Men - Mean: 77 - SD: 21 - Missing: 1 Women - Mean: 64 - SD: 14 - Missing: 4
Time between fractures (months)	Mean: 27.5 SD: 28.9 Missing: 0	
Hospital stay (days)	Mean: 20.5 SD: 17.8 Missing: 0	Mean: 16.3 SD: 17.0 Missing: 0
Operation time (min) ^a	Mean: 79 SD: 44 Missing: 0	Mean: 93 SD: 42 Missing: 0
Pre-operative ASA	1: 2 2: 24 3: 5 4: 0 Missing: 1	1: 1 2: 20 3: 6 4: 1 Missing: 4
Time between arrival in hospital and operation (h)	Mean: 17 SD: 11 Missing: 2 24 h: 8 - ASA 1: 1 - ASA 2: 6 - ASA 3: 1 - ASA 4: 0 - ASA unknown: 0	Mean: 14 SD: 9 Missing: 0 24 h: 5 - ASA 1: 0 - ASA 2: 3 - ASA 3: 1 - ASA 4: 0 ASA unknown: 1
Blood loss (ml)	Mean: 342 SD: 492 Missing: 18	Mean: 275 SD: 197 Missing: 16
Osteoporosis (Singh index, range 1–6)	Fractured hip 1 1: 6 2: 4 3: 5 4: 3 5: 2	Non fractured hip 1: 2 2: 3 3: 4 4: 5
		Fractured hip 2 1: 9 2: 2 3: 7 4: 5 5: 0

Table 1 (continued)

Characteristic	Fracture 1		Fracture 2
	6: 2	5: 4	6: 1
	Missing: 10	6: 4	Missing:8
		Missing: 10	
Osteoporosis medication	Before fracture 1	After fracture 1	After fracture 2
	Yes:2	Yes: 3	Yes: 7
	No: 17	No: 17	No: 13
	Missing: 13	Missing:12	Missing:12
Trauma mechanism	Stumbling: 18		Stumbling: 17
	Staircase:1		Staircase: 0
	Missing:13		Missing: 15
Anaesthetics	General: 10		General: 10
	Spinal: 22		Spinal: 19
	Missing: 0		Missing: 3
Hb pre-operative	Mean: 8.2		Mean: 8.0
	SD: 1.0		SD: 0.9
	Missing: 3		Missing: 7
Hb 1 day post-operative	Mean: 6.3		Mean: 6.4
	SD: 1.1		SD: 1.2
	Missing: 16		Missing: 11
Hb 2 days post-operative	Mean: 6.4		Mean: 6.6
	SD: 0.6		SD: 1.0
	Missing: 15		Missing: 13
Ht pre-operative	Mean: 0.40		Mean: 0.38
	SD: 0.04		SD: 0.04
	Missing: 4		Missing: 10
Ht 1 day post-operative	Mean: 0.30		Mean: 0.32
	SD: 0.05		SD: 0.05
	Missing: 16		Missing: 13
Ht 2 days post-operative	Mean: 0.31		Mean: 0.32
	SD: 0.03		SD: 0.04
	Missing: 16		Missing: 16

SD standard deviation

Hb Hemoglobin Unit = mmol/L; *Ht* hematocrit Unit = L/L

Weight = in kg Hb = hemoglobin concentration in mmol/l Ht = hematocrit in l/l.

Differences were significant only for gender, time between fractures and osteoporosis

32 patients (75%) (intracapsular, extracapsular; Table 2). Thirty one of the 32 intracapsular fractures were femoral neck fractures and one was a subcapital fracture. Six of the extracapsular fractures were subtrochanteric and 26 were trochanteric. In the group of patients with two intracapsular fractures (Table 3), five out of 12 patients were given the same implant for both fractures. Of all patients with two intracapsular fractures, the first fracture was treated in six of the patients with a DHS, two patients were treated three cannulated screws, and four with (hemi)arthroplasty. For the second intracapsular fracture two patients were treated with a DHS, two three cannulated screws and eight with (hemi)arthroplasty. In the group with two extracapsular

fractures at the successive time intervals, the first and second occurring fracture were treated in three (25%) of the 12 patients with the same implant (Table 4). The other differences in implant choice for the first and second intra- and extracapsular fractures are shown in Tables 4 and 5. The kappa for agreement in implant choice and for localisation of fractures was 0.12 for intracapsular fractures and -0.23 for extracapsular fractures.

The average hospital stay was 20.5 days (SD 17.8) for the first fracture compared to 16.3 days (SD 17.0) for the second fracture. The mean operation time for the first fracture was 79 min (SD 44), compared to 93 min (SD 42) for the second procedure. The mean weight for women

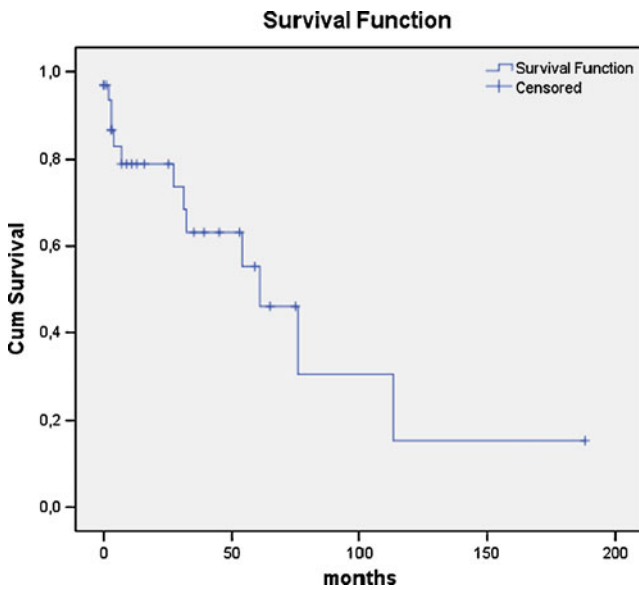


Fig. 1 Kaplan-Meier survival curve after second fracture

declined from 66 kg (SD 14) to 64 (SD 14) ($p=0.62$) between fractures. In men the opposite was noticed, as men gained weight between the first (mean 68 kg, SD 25) and second fracture (mean 77 kg, SD 21; $p=0.30$). For both the first and second fracture the preoperative comorbidity (ASA) classification was 2 (range 1–4). The trauma mechanisms involved falls while walking, except for one fall from the first step of a staircase (30 cm height) leading to a first hip fracture. For both the first and second operations ten patients received general anaesthesia and 22 had locoregional anaesthesia. There was no significant difference in blood parameters between the first and second hip fracture. The mean time between arrival at the hospital and surgery was 17 hours (SD 11) for the first fracture and 14 hours (SD 9) for the second fracture. Eight patients with a first hip fracture had surgery 24 hours or more after arrival at the hospital, compared to five patients for the second hip fracture.

There was a significant difference in the Singh index when the first fracture (range 1–6) was compared to the non fractured contra-lateral hip (range 1–6; $p=0.007$), and when the proximal femur at the time of the second hip fracture

was compared to its index at the time of first fracture (range 1–6; $p=0.008$, Wilcoxon test).

The mean number of complications after the first hip fracture was 1.0 compared to 0.8 after the second fracture (Table 5). Six patients had complications in the operation area after a first fracture and in four patients after a second hip fracture. Nine patients had other, non operation wound-related complications after the first hip fracture and eight after the second fracture.

Before the first fracture two patients were treated and after the first fracture three patients were treated with osteoporosis medication. After the second fracture seven patients were treated, but information about medication was missing from twelve patients.

Discussion

During the time frame of this 16-year follow-up, the prevalence of low impact bilateral proximal femoral fractures in the studied population was relatively low (2%) compared to other studies reporting a second hip fracture in 5–20% [5, 6, 14, 15]. One explanation could be that in our study patients with diseases or medication known to have a negative effect on bone metabolism were excluded. Another, and more probable explanation is the variability in patient attendance at the same hospital. Since the Netherlands, and particularly the region around Leiden, is a very dense populated area with three trauma centers, it is possible that a patient will be allocated to different hospitals for a first and second hip fracture. Furthermore, patients who were treated for a hip fracture in the LUMC after 2007 were not included in this study. Fractures occurring before 1992 were however noted from the hospital charts.

The survival of the patients in the present study is comparable to other studies [16]. The average time between arrival and operation in this study was short, which reduces mortality [17]. A possible explanation for the fact that patients often have the same type of fracture in both hips is that fractures have a multi-factorial cause, i.e., not only the bone mineral density and bone structure, but also the

Table 2 Distribution of fracture site per patient at the first and second occurring fracture

Fracture 1	Fracture 2	Intracapsular		Extracapsular		Total
		Subcapital	Femur neck	Tochanteric	Subtrochanteric	
Intracapsular	Subcapital	0	0	0	0	0
	Femoral neck	1	11	4	0	16
Extracapsular	Trochanteric	0	3	8	0	11
	Subtrochanteric	0	1	3	1	5
Total		1	15	15	1	32

Table 3 Choices of implant for intracapsular fractures at the first and second fracture

	Fracture 1	Fracture 2			Total
		DHS	Cannulated screw	(Hemi)arthroplasty	
DHS	1	1	4	6	
Cannulated screw	0	1	1	2	
(Hemi)arthroplasty	1	0	3	4	
Total	2	2	8	12	

DHS dynamic hipscrew (Synthes Inc)

geometry plays an important role [18]. An interesting finding in this study is the fact that both hips have a different Singh index at the time of the first fracture, compared to the second fracture. The influence of immobilisation on the occurrence of osteoporosis after the first hip fracture, as mentioned by some authors [19], will be small, since patients were ambulated the day after surgery. The degree of osteoporosis was noted to have deteriorated further after the first fracture, and might therefore have been prevented with adequate osteoporosis medication. In this study only seven patients of 32 received any form of osteoporosis medication (vitamin D, calcium and bifosphonates). Also other studies show that osteoporosis is seldom treated after a hip fracture [15, 20]. Treating all patients with osteoporosis after a first hip fracture could prevent 43% of the second hip fractures [21]. In none of the patients was a DEXA-scan carried out, but according to the Singh index at least half of the patients suffered from osteoporosis at the time of the first fracture, although they did not receive medication afterwards. When operating upon hip fractures diagnosing osteoporosis is very important. A Singh index on a regular X-ray can give important information about the degree of osteoporosis. Treating osteoporosis should always be considered, as it can prevent further hip fractures.

Osteoporotic fractures are known to be preceded by a decline in weight, due to a decline in estrogens in postmenopausal women [22]. In this study the 3 kg difference was not a significant decline in weight for women, probably due to underpower of the study.

The hospital stay in this study is relatively long. The cause of this is unknown, but a hypothesis is that it is relatively

Table 4 Choices of implant for extracapsular fractures at the first and second fracture

Fracture 1	Fracture 2			
	DHS	Gamma-nail	PFN	Total
DHS	0	1	0	1
Gamma-nail	1	1	4	6
PFN	1	2	2	5
Total	2	4	6	12

DHS dynamic hipscrew (Synthes Inc); PFN proximal femoral nail (Synthes Inc); Gamma nail (Stryker Inc)

difficult to find places for patients in nursing homes. Another explanation is that a few patients suffered from many complications and for that reason stayed longer in hospital, which contributes to a long average stay. An interesting but not significant ($p=0.34$) finding in this study is the shorter hospital stay after a second hip fracture. Others suggest that the recovery of patients with a subsequent contra-lateral hip fracture is similar to the first hip fracture [23].

Although 24 of 32 patients had a similar type of femoral fracture, only eight out of these 24 patients received the same implant in both hips. A factor which has to be mentioned is that Gamma-nails and PFN are implants of the same type, but used by different specialists. If the Gammannail and PFN are considered to be a comparable implant, 14 of these 24 patients received the same type of implant. The main reason to choose an implant is the type of fracture [24]. Undisplaced intracapsular fractures should be treated, according to the Dutch guidelines, with internal fixation using a method that is familiar to the surgeon [24]. According to the AO guidelines there is no evidence of

Table 5 Complications

Complications	Fracture 1	Fracture 2
Number of complications	Mean: 1.0 0: 8 1: 6 2: 4 3: 2 Missing: 12	Mean: 0.8 0: 10 1: 7 2: 0 3: 3 Missing: 12
Complications operation area		
Total	6	4
Wound infections	3	4
Dislocation	2	0
Necrosis	1	0
Pseudo-arthrosis	2	0
Haematoma	1	0
Other complications		
Total	9	8
Delirium	5	6
Decubitus	3	2
Embolus	0	1
Renal/ Bladder complications	3	3

the superiority of one implant over the other for the fixation of intracapsular fractures. However, patients with a short life expectancy or a low mobility demand are considered eligible for a hemi-arthroplasty. The latter is known to have a lower risk of failure than a DHS or cannulated screws in these patients [24]. But also other characteristics of the fracture (bone quality, displacement and comminution) and patients characteristics (age, functional level before the fracture) are important [3]. Internal fixation by screws and nails is associated with less initial operating trauma, but has an increased risk of re-operation compared to hemiarthroplasty [25]. Also co-morbidity is an important factor in choosing an implant. Parkinson, rheumatoid arthritis or osteoarthritis patients for example require total hip replacement as they have a high risk of postoperative prosthetic dislocation [3]. Probably one of the most important reasons to choose a specific implant is preference and experience of the surgeon. Research showed that treatment choice based on physiological status does not significantly improve clinical decision making. This study showed clearly that implants were randomly chosen, instead of trying to give the patient symmetrical hips.

Conclusion

This small series shows a significant effect of the radiographic osteoporotic assessment as measured with the Singh index on the occurrence of a second fracture of the proximal femur.

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