Operative treatment of patients with pertrochanteric femoral fractures outside working hours is not associated with a higher incidence of complications or higher mortality

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This retrospective cohort study was conducted to investigate whether operative treatment of patients with a pertrochanteric femoral fracture outside working hours is associated with an increased risk of complications and higher mortality. During the study period 165 patients were operated on outside working hours and 123 were operated on during working hours (08.00 to 17.00). There was no difference in the rate of early complications (outside working hours 33% versus working hours 33%, $p = 0.91$) or total complications during follow-up (outside working hours 40% versus working hours 41%, $p = 0.91$). Both in-hospital mortality (outside working hours 12% versus working hours 11%, $p = 0.97$) and mortality after one year (outside working hours 29% versus working hours 27%, $p = 0.67$) were comparable. Adjustment for possible confounders by multivariate logistic regression analysis revealed no increased risk of complications when patients were operated on outside working hours.

On the basis of these data, there is no medical reason to postpone operative reduction and fixation in patients with a proximal femoral fracture until working hours.

Fractures of the hip are the second most frequent cause of hospitalisation in elderly patients.¹ Each year there are about 17 000 such fractures in The Netherlands,² and around 340 000 in the United States.³ Due to the increase in the elderly population, the number of patients with a fracture of the hip is expected to increase and their treatment will become an increasing burden on systems of healthcare.

The timing of surgery for these fractures is controversial, with conflicting results from different studies.⁴⁻¹⁰ Best practice guidelines¹¹ advise operation within 24 hours of the fracture. In many large series early operative treatment is associated with a lower mortality and fewer post-operative complications.^{12,13} Although it is difficult to comply with these guidelines¹⁴ the focus on early treatment tends to increase the number of operations undertaken outside working hours. Kelz et al¹⁵ recently showed that general surgical patients operated on between 16.00 and 23.00 have a higher complication rate than patients operated on during working hours. The timing of surgery in hip fractures has long been the subject of debate. Recent studies have shown an increased risk of complications in patients

admitted or treated outside working hours.^{16,17} The aim of this retrospective cohort study was to compare the outcome in patients treated operatively for pertrochanteric femoral fractures outside working hours and during working hours in terms of mortality, post-operative complications and survival.

Patients and Methods

All patients who received operative treatment for pertrochanteric femoral fractures (World Health Organisation ICD-10) code S72.1)¹⁸ in our hospital between 2000 and 2007 were included in this study.

Our department is part of a teaching hospital, in which 11 surgeons and 12 residents participate. Patients with a hip fracture are operated on by an experienced general surgeon or a specific trauma surgeon, who have each performed > 100 operative procedures for these injuries, or by a resident under their direct supervision. All patients are screened pre-operatively by a cardiologist and/or a chest physician, and prepared as necessary in collaboration with an anaesthetist. The operating theatre functions routinely from 08.00 until 17.00 from Monday to Friday. Outside these hours, one team is on call for emergency procedures,

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with a backup team available. Immediately after operation patients are monitored in the post-anaesthesia care unit before returning to the ward. If necessary, a medium care or intensive care facility is available for post-operative monitoring. Post-operatively, patients are mobilised with crutches or a walker, encouraged to stay out of bed, sit up in a chair, and exercise the operated hip and leg under the direct supervision of a physiotherapist.

Since 1995 we have used an electronic patient record system to prospectively record all relevant patient data and complications. Upon admission to the emergency department, a complete history, including comorbidities, pre-morbid ambulatory state and living conditions, is recorded. After consultation age, gender, comorbidity, American Society of Anesthesiologists (ASA)¹⁹ classification, time and cause of injury (high-energy or low-energy trauma), date and hour of diagnosis, free-text description of the diagnosis, and the appropriate code is recorded. Post-operatively, the date, starting time and duration of the operation, type of operation both as free text and as code, blood loss, the type of implant either dynamic hip screw, or pertrochanteric femoral nail (Synthes, Bettlach, Switzerland), operating surgeon or surgical trainee, and a detailed description of the procedure performed, is recorded. In the electronic medical record the complete post-operative course is registered, including length of hospital stay and any complications. All patient records were reviewed and if necessary, corrected for errors of registration. All the radiographs were reviewed and the fractures classified using the AO system.²⁰

For the prospective registration of complications, we used the standard definition as given by the Association of Surgeons of The Netherlands: 'A complication is any condition or event, unfavourable to the patient's health, causing irreversible damage or requiring a change in therapeutic policy'.²¹ These complications are coded prospectively according to the Trauma Registry of the American College of Surgeons Committee on Trauma.²² Besides this, a free-text description of the complication is also recorded. As prospective registration of complications is known to be often incomplete and inconsistent,²³ all patient records were fully reviewed for non-registered complications, and the entries were checked. Early post-operative complications were defined as occurring within 30 days of surgery. Late complications were defined as any major adverse event that occurred in the year following the operation which had a clear relationship to the hip fracture or osteosynthesis. Total complications combined both early and late complications. In-hospital mortality was defined as death within 30 days of surgery. As this is a retrospective review, no actual patient follow-up for the specific purpose of this study took place. Our hospital protocol dictates that patients with a hip fracture should be followed for one year after surgery. When the protocol was violated and post-operative follow-up was less than one year, the patient's general practitioner was telephoned to inquire whether the patient was still alive, and whether they had visited any

doctor since discharge from our outpatient department, in order to ensure that no complications had been missed. Patients were excluded if follow-up was for less than 30 days and the general practitioner could not provide reliable information, or when neither the patient nor the general practitioner could be traced.

An operative procedure was regarded as performed during working hours if it was started between 08.00 and 17.00 from Monday to Friday. Outside these hours the procedure was recorded as performed outside working hours.

Statistical analysis. All data were analysed using SPSS version 16.0 (SPSS Inc., Chicago, Illinois). Differences between groups were analysed by chi-squared test for 2 × 2 tables. Non-parametric data were analysed using the Mann-Whitney U test, and Student's *t*-test was used for continuous variables with a normal distribution. Kaplan-Meier analysis was used for survival times, and survival was compared using the log-rank test. Multivariate logistic regression analysis was used to calculate the odds ratio (OR) of in-hospital and one-year mortality, early complications and total complications for patients operated on outside working hours, compared with patients operated on during working hours. In order to adjust for confounding factors, we entered the variables of age, gender, presence of dementia, diabetes, cardiac comorbidity or pulmonary comorbidity, pre-morbid ambulant status, pre-morbid living situation, type of fracture, operation performed by trauma surgeon, time from diagnosis to surgery and the ASA classification. In the final model, all confounders were included that changed the regression coefficient for outside working hours by 10% or more, independent of significance. Finally, a *post hoc* power analysis was performed to determine the difference in mortality and complication rate that our sample size was large enough to detect.

Results

During the study period 298 pertrochanteric femoral fractures were treated operatively. Outside working hours, 165 patients were operated on, with a median starting time of 19.00 (17.00 to 22.00) from Monday to Friday, and a median of 14.00 (09.00 to 22.00) during weekends. During working hours 123 patients were operated on, with the operation starting at a median of 14.00 (08.00 to 16.00). None of the patients had simultaneous bilateral fractures. Ten patients were followed up for less than 30 days and were excluded from the analysis (six outside working hours and four operated on during working hours, *p* = 0.87). Patient characteristics are shown in Table I. Both groups were comparable with respect to age, ASA classification, comorbidity, high-energy trauma and fracture type. In the outside working hours group there were more patients living in a medical care facility. There was a trend towards more female patients and more patients using a walking aid in the working hours group, but this difference was not statistically significant.

Table I. Baseline patient characteristics

	Outside working hours (%)	Working hours (%)	p-value*
Number of patients	165 (57)	123 (43)	
Age in years (range)	79 (32 to 98)	79 (20 to 99)	0.94
Number of females	121 (73)	101 (82)	0.08
ASA grade (%)			
I	12 (7)	16 (13)	0.10
II	76 (46)	51 (42)	0.44
III	71 (43)	53 (43)	0.99
IV	6 (4)	3 (2)	0.56
Number with comorbidity			
Cardiovascular	49 (30)	37 (30)	0.94
Pulmonary	28 (17)	20 (16)	0.87
Diabetes mellitus	24 (15)	17 (14)	0.86
Dementia	20 (12)	16 (13)	0.82
High energy trauma	3 (2)	6 (5)	0.14
Delirium on admission	1 (0.6)	0 (0)	0.39
Premorbid ambulant status			
No walking aid	59 (36)	34 (27.6)	0.15
Walking stick or walker	102 (62)	88 (71.6)	0.08
Wheelchair or bed dependent	4 (2)	1 (0.8)	0.31
Premorbid living situation			
Independent	89 (54)	76 (62)	0.18
Social care facility	53 (32)	40 (33)	0.94
Medical care facility	23 (14)	7 (6)	0.02
Fracture classification (AO/OTA)			
31-A1	71 (43)	48 (39)	0.49
31-A2	64 (39)	56 (46)	0.25
31-A3	30 (18)	19 (15.5)	0.54
Number with pathological of fracture	2 (1.2)	2 (1.6)	0.77

* all p-values were calculated using the chi-squared test

Table II shows the operative characteristics, complications and mortality for both groups. They were comparable regarding the type of implant, blood loss and duration of hospital stay. During working hours, the procedure was more frequently performed by a trauma surgeon. The duration of the operation was similar in both groups. The time from diagnosis to operation more frequently exceeded both 24 and 48 hours in patients operated on during working hours. There was no difference between the groups with respect to early or overall complication rates. In patients with complications, the median number of complications was one (interquartile range (IQR) 1 to 1.25) in patients operated on outside working hours and one (IQR 1 to 2) in patients operated on during working hours ($p = 0.10$). Of all patients operated on during working hours, 16 (13%) needed one or more re-operations, compared with 21 (13%) operated on outside working hours. In these patients, a median of one reoperation (IQR 1 to 1.75) was necessary in working hours compared with a median of one (IQR 1 to 5.5) in outside working hours ($p = 0.15$). In-hospital mortality and one-year mortality during follow-up

were similar in both groups. Duration of follow-up in patients surviving both hospital admission and more than 30 days was less in the group operated on outside working hours (median 437 days; IQR 145 to 1013), ($p = 0.017$) than for the group operated on in working hours (median 757 days; IQR 189 to 1362) but the median time to in-hospital death was not statistically different (working hours group 21 days, IQR 5.5 to 25 *versus* outside working hours group ten days, IQR range 6 to 23; $p = 0.69$, Mann-Whitney U test).

In the univariate model for patients operated on outside working hours OR for early complications was 0.97 (95% confidence interval (CI) 0.59 to 1.60), the OR for total complications was 0.97 (95% CI 0.61 to 1.57), the OR for in-hospital mortality was 1.01 (95% CI 0.49 to 2.11) and the OR for one-year mortality was 1.12 (95% CI 0.66 to 1.89). Multivariate logistic regression analysis revealed no confounding effect of age, gender, ASA classification, cardiac comorbidity, pulmonary comorbidity, diabetes, dementia, premorbid ambulant status, premorbid living situation, type of fracture, time from diagnosis to surgery, or whether

Table II. Operative characteristics and outcome

	Outside working hours (%)	Working hours (%)	p-value*
Number of patients	165	123	-
Time from diagnosis to surgery (%)			
< 24	122 (73.9)	66 (53.6)	< 0.001
24 to 48	36 (21.8)	40 (32.5)	< 0.0415
> 48	7 (4)	17 (14)	< 0.0036
Type of osteosynthesis (%)			
Dynamic hip screw	82 (49.7)	54 (43.9)	0.33
Pertrochanteric femoral nail	82 (49.7)	68 (55.3)	0.35
Other	1 (0.6)	1 (0.8)	0.83
Median starting hour of the operation			
Weekdays	19 (17 to 22)	14 (8 to 17)	-
Weekends	14 (9 to 22)	-	-
Operation time in mins (median IQR†)	62 (49 to 67)‡	67 (52 to 87)‡	0.07
Blood loss in ml (median IQR)	100 (50 to 200)‡	100 (100 to 200)‡	0.52
Number of operations by trauma surgeon	84 (51)	89 (72)	< 0.001
Length of hospital stay in days (median IQR)	11 (6 to 18)‡	11 (8 to 19)‡	0.49
Number of total complications (%)	66 (40)	50 (41)	0.91
Number of early complications (%)	54 (33)	41 (33)	0.91
Number of in-hospital mortality (%)	19 (12)	14 (11)	0.97
Number of one-year mortality (%)	48 (29)	33 (27)	0.67

* p-values calculated using the chi-squared test, unless otherwise stated

† IQR, interquartile range

‡ p-values calculated using Mann-Whitney U test

Table III. Logistic regression analysis

Patients operated on outside working hours (n = 165)	Univariate model*			Multivariate model†		
	β	p-value	OR (95% CI)	β	p-value	OR (95% CI)
In-hospital mortality	0.01	0.97	1.01 (0.49 to 2.11)	0.11	0.77	1.12 (0.53 to 2.40)
One-year mortality	0.11	0.67	1.119 (0.66 to 1.89)	0.32	0.26	1.37 (0.79 to 2.39)
Early complications	-0.27	0.91	0.97 (0.59 to 1.60)			
Total complications	-0.03	0.91	0.97 (0.61 to 1.57)			

* OR, odds ratio; 95% CI, 95% confidence interval

† adjusted for time from diagnosis to surgery

or not the operation was performed by a trauma surgeon, on the development of both early and late complications. None of these variables changed the regression coefficient for those operated on outside working hours by 10% or more. After adjustment for time to operation, patients operated on outside working hours had a non-significantly higher risk of in-hospital death (OR 1.12; 95% CI 0.53 to 2.40) as well as a non-significant higher risk of death after one year (OR 1.37; 95% CI 0.79 to 2.39). These results are shown in Table III.

There were no difference in surgery-related complications between the groups. The incidence of cardiac, neurological, gastrointestinal and infectious complications was similar. In patients operated on during working hours there were more pulmonary complications (outside working hours four, $p = 0.03$ versus ten for working hours). Kaplan-

Meier survival analysis (Fig. 1) showed no difference in survival between the groups ($p = 0.22$).

A *post hoc* power analysis showed that with a power of 0.80 and a significance level of 0.05, our sample size would be large enough to detect an increase from 11% in-hospital mortality to 25%. With regard to complications, our sample size would be large enough to detect an increase in early complications from 33% to 50%.

Discussion

We believe that this study is the first to investigate the relationship between the time of day of surgery and the incidence of complications and mortality in patients with a pertrochanteric fracture. We found that the risk of complication and mortality were similar in both groups. Only pulmonary complications were more frequently observed in

Fig. 1

Kaplan-Meier curve showing survival after operative treatment for pertrochanteric fractures comparing patients operated on outside working hours (OWH) and during working hours (WH).

patients operated on during working hours, but a relationship with prolonged time from diagnosis to surgery was not found. Interestingly, there was no difference in surgery-related complications, which suggests that the performance of surgeons at both times of day is comparable. The similar incidence of non-surgery-related complications reflects a comparable level of peri-operative care at both times of day. Long-term survival was comparable in both groups, although from one year onwards a trend towards increased mortality was seen in patients operated on outside working hours. This probably reflects the somewhat larger proportion of ASA II and IV patients operated on at this time. The higher proportion of men in the group of patients operated on outside working hours may also be important. The study included many elderly patients, and as men have a shorter life expectancy, a higher proportion of men may contribute to decreased survival in patients operated on at this time.

The effect that time of day of operative hip fracture treatment, has on outcome in terms of complications and mortality may be a factor. This has also been found in other fields of health care. In a study on general and vascular surgical procedures, a 1.6 times higher risk of complications, but not mortality was found in patients operated on outside working hours.¹⁵ Likewise, admission to the intensive care unit during weekends has been associated with a higher mortality,¹⁷ and outcome following primary angioplasty for acute myocardial infarction has been reported as worse for procedures performed outside working hours.^{16,24}

Factors underlying an increased risk of complications from surgery outside working hours can be both patient and health-care provider related. From a physiological point of view, patient-related factors are less likely to contribute to this adverse effect than factors related to the medical staff. This hypothesis is supported by several non-medical studies that have found an association between time of day and the risk of vocational accidents and changes in driving performance.²⁵⁻²⁸ As with other technical skills, surgery is probably influenced by the same physiological processes that increase the risk of technical failure in the evening and night. Differences in the knowledge and expertise of the medical staff might also be responsible for differences in outcome. Our study, however, does not show any effect of the time of day in patients operated on for hip fractures in our hospital. Several explanations for this phenomenon are possible. First, it has been shown that early operative treatment of hip fractures can prevent complications.⁶⁻¹⁰ The benefit of early surgery may outweigh the risk of complications in emergency or semi-emergency procedures. Moreover, the complexity of the operation and post-operative care of a hip fracture may be less than that of vascular surgery,¹⁵ angioplasty for myocardial infarction,^{16,24} or the treatment of severely ill patients in the intensive care unit. It is likely that the level of organisation of care outside working hours is more important than the time at which surgery is performed. The level of care and facilities in the intensive care unit for patients requiring coronary angioplasty far exceeds that needed for patients with a pertrochanteric hip fracture. Thus the difference between the level of care outside working hours and during working hours may be small or non-existent. In pertrochanteric fractures, good clinical practice requires the operation to be performed as soon as possible and under the best possible circumstances. In the pre-operative phase this requires thorough medical assessment and treatment by the cardiologist, chest physician and anaesthetist. At operation, an anaesthetist, a skilled surgeon and well-trained nursing staff are essential. Post-operative care requires a post-anaesthetic care unit and the availability of medium or intensive care facilities to monitor the patient. Only if such facilities are not available outside working hours, or if the patient's medical treatment requires more time, should surgery be delayed.

This study has some limitations. Because of lack of data regarding the functional outcome, we cannot rule out differences in functional recovery in patients operated on outside working hours compared with those operated on during working hours. The study is of observational and non-randomised design. We believe a randomised study would be unethical, as it would require the operation to be delayed in some patients, with an associated higher risk of complications⁸⁻¹² and mortality.^{6,12} Another confounding factor might be that healthier patients with simple fractures were operated on immediately, whereas surgery in patients with comorbidities or complex fractures was postponed

and performed the following day during working hours. However, adjustment for time from diagnosis to surgery, fracture classification and other patient characteristics by logistic regression did not change the results of the study in any way. A final factor that needs consideration is the sample size. Because our study population contained only 288 patients, it is underpowered to rule out smaller, but possibly clinically relevant, differences. However, as our study shows almost identical complication and mortality rates in patients operated on outside working hours, compared with those operated on during working hours, it is unlikely that a study with larger numbers would reveal clinically relevant differences in complication and mortality rates. A major strength of this study is the completeness and reliability of all data due to prospective recording in a structured electronic medical record system. Moreover, the accuracy of all data was checked and if necessary, corrected after agreement by all authors. A final advantage of this observational study is that it reflects common practice in an average European teaching hospital.

This study does not support the proposition that operative reduction and fixation in patients with a proximal femoral fracture should be postponed to normal working hours to reduce morbidity and mortality. Healthy patients (ASA class I-II) should be operated on without delay. In patients with significant comorbidities the operation should be postponed until they are properly prepared for operation. If, however, essential hospital facilities are not available outside working hours, it is wise to wait and perform the operation during working hours. In all other situations the results of this study suggest that surgery for pertrochanteric femoral fractures outside working duty hours is safe.

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