■ TRAUMA

Influence of time to surgery on clinical outcomes in elderly hip fracture patients

AN ASSESSMENT OF SURGICAL POSTPONEMENT DUE TO NON-MEDICAL REASONS

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Aims

Factors associated with high mortality rates in geriatric hip fracture patients are frequently unmodifiable. Time to surgery, however, might be a modifiable factor of interest to optimize clinical outcomes after hip fracture surgery. This study aims to determine the influence of postponement of surgery due to non-medical reasons on clinical outcomes in acute hip fracture surgery.

Methods

This observational cohort study enrolled consecutively admitted patients with a proximal femoral fracture, for which surgery was performed between 1 January 2018 and 11 January 2021 in two level II trauma teaching hospitals. Patients with medical indications to postpone surgery were excluded. A total of 1,803 patients were included, of whom 1,428 had surgery < 24 hours and 375 had surgery ≥ 24 hours after admission.

Results

Prolonged total length of stay was found when surgery was performed ≥ 24 hours (median 6 days (interquartile range (IQR) 4 to 9) vs 7 days (IQR 5 to 10); p = 0.001) after admission. No differences in postoperative length of hospital stay nor in 30-day mortality rates were found. In subgroup analysis for time frames of 12 hours each, pressure sores and urinary tract infections were diagnosed more frequently when time to surgery increased.

Conclusion

Longer time to surgery due to non-medical reasons was associated with a higher incidence of postoperative pressure sores and urinary tract infections when time to surgery was more than 48 hours after admission. No association was found between time to surgery and 30-day mortality rates or postoperative length of hospital stay.

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Introduction

Hip fractures in elderly patients are associated with high complication rates. Patients are frequently unable to return home and suffer from long-term disability after hip repair and reconstructive surgery.[1] Besides, hip fractures are also associated with 30-day mortality rates varying between 8% and 13%.[2] Various patient characteristics seem to be associated with an increased risk of death after hip fracture surgery.[3] These factors mainly result from frailty and are often unmodifiable.[4] To optimize care for frail hip fracture patients, modifiable perioperative factors are of particular interest.[4] One of these potential modifiable factors is time between admission and surgery. Although literature regarding optimal timing of surgery has shown mixed results,[5-7] current guidelines advise early surgery.[8-15] However, the definition of early surgery varies broadly from six to 72 hours. Early surgery is advised because postponement of surgery is associated with complications such as pneumonia, pressure sores, and delirium. Moreover, when surgical postponement is protracted, a longer total hospital stay and higher mortality rates are reported.[5-7,16-20] If an extended period is required to preoperatively optimize cardiac or pulmonary conditions, or to reduce risk of bleeding by eliminating antithrombotic drugs, mortality rates do not increase.[16,21] Postponement of surgery in frail patients requiring preoperative optimization

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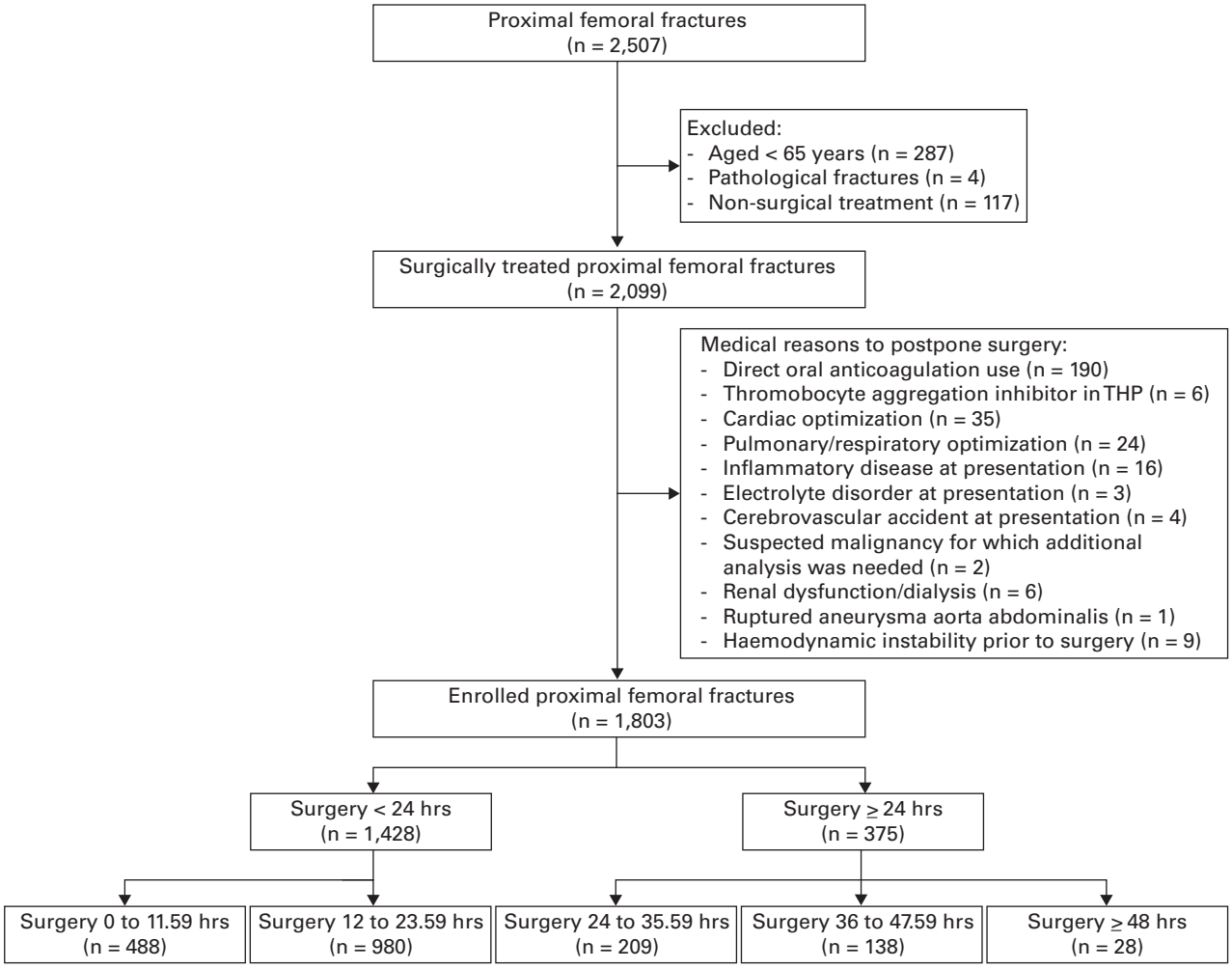

Fig. 1

Flowchart of patient inclusion. THP, total hip prosthesis.

leads to longer delays than are seen in less frail patients.[19] The confounding of any delay by indication has left previous studies unable to determine the influence of postponing surgery due to non-medical reasons on clinical outcomes in geriatric hip fracture patients.[8,22-26] This study aims to investigate the influence of postponement due to non-medical reasons, by exclusively analyzing patients who had differences in time to surgery due to non-medical reasons. Primary outcomes were incidence of postoperative complications, including deep surgical site infections (SSIs), pneumonia, urinary tract infections, decubital ulcers, delirium, and mortality. Secondary outcome was length of hospital stay.

Methods

Patient selection. This study is an observational cohort study with real-time registration of patients in a prospective hip fracture database (FAMMI trial).[27] All consecutively admitted patients between 1 January 2018 and 11 January 2021 in two level II trauma teaching hospitals located in Rotterdam, the Netherlands, with fractures of the femoral neck and (sub)trochanteric area and an age of ≥ 65 years who were treated with osteosynthesis (i.e. cannulated screws, sliding hip screw, or cephalocondylar nail system) or prosthesis (i.e. hemiarthroplasty or total hip arthroplasty) were screened for eligibility. Exclusion criteria were pathological fractures and medical indications to postpone surgery. The minimum follow-up duration was 30 days after surgery.

A total of 2,507 patients were screened for eligibility, of whom 1,803 were enrolled in the study (Figure 1). Medical indications to postpone surgery were most frequently direct oral anticoagulant (DOAC) use (n = 190; 66%), cardiac optimization (n = 35; 12%), and pulmonary/respiratory optimization (n = 24; 8%).

Patient variables. Baseline characteristics were extracted from patients' medical charts. Preoperative performance and frailty of enrolled patients were assessed using the American Society of Anesthesiologists (ASA) grade,[28] Charlson Comorbidity Index (CCI),[29] and Nottingham Hip Fracture Score (NHFS).[3] Patients with a NHFS ≤ 4 are considered to have a low risk of death within 30 days. Those with a NHFS ≥ 5 are considered high-risk

Table I. Baseline characteristics of 1,803 included patients.

Factor	Overall (n = 1,803)	< 24 hrs (n = 1,428)	≥ 24 hrs (n = 375)	p-value
Mean age, yrs (SD)	83 (8)	82 (8)	83 (8)	0.034*
Female, n (%)	1,265 (70)	998 (70)	267 (71)	0.621†
BMI, n (%)				0.355†
< 18.5 kg/m²	95 (5)	77 (6)	18 (5)	
18.5 to 30 kg/m²	1,078 (60)	840 (59)	238 (63)	
> 30 kg/m²	108 (6)	90 (6)	18 (5)	
Unknown	522 (29)	421 (29)	101 (27)	
Comorbidities, n (%)				
Dementia	469 (26)	379 (27)	90 (24)	0.318†
Cardiovascular disease	1,110 (62)	870 (61)	240 (64)	0.276†
Myocardial infarction	137 (8)	99 (7)	38 (10)	0.037†
Cerebrovascular accident	228 (13)	173 (12)	55 (15)	0.186†
COPD	221 (12)	173 (12)	48 (13)	0.719†
Antithrombotics, n (%)				
No antithrombotics	914 (51)	737 (52)	177 (47)	0.128†
Vitamin K antagonist	258 (14)	174 (12)	84 (22)	< 0.001†
Thrombocyte aggregation inhibitor	638 (35)	524 (37)	114 (30)	0.023†
Residential status, n (%)				0.124†
Home	1222 (68)	957 (67)	265 (70)	
Semi-independent nursing home	155 (9)	119 (8)	36 (10)	
Nursing home	426 (23)	352 (25)	74 (20)	
Median NHFS (IQR)	5 (4 to 6)	5 (4 to 6)	5 (4 to 6)	0.999‡
ASA grade, n (%)				0.028†
1 to 2	535 (30)	441 (31)	94 (25)	
3 to 4	1,268 (70)	987 (69)	281 (75)	
Mean CCI (SD)	5.1 (1.7)	5.0 (1.7)	5.3 (1.7)	0.016‡
Mean preoperative Hb level, g/l (SD)	140.4 (18.0)	140.4 (18.0)	142.2 (16.2)	0.064*
Median preoperative GFR, ml/min/1.73 m² (IQR)	68 (50 to 80)	69 (50 to 81)	66 (51 to 79)	0.633*
FICB, n (%)	299 (17)	233 (16)	66 (18)	0.556†
Unknown, n	1 (0)	1 (0)	0 (0)	N/A
Median VAS pain preoperative (IQR)	4 (3 to 5)	4 (3 to 5)	4 (3 to 5)	0.479*

*Independent-samples *t*-test.
†Chi-squared test.
‡Mann-Whitney U test.
ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; COPD, chronic obstructive pulmonary disease; FICB, fascia iliaca compartment block; GFR, glomerular filtration rate; Hb, haemoglobin; IQR, interquartile range; N/A, not applicable; NHFS, Nottingham Hip Fracture Score; SD, standard deviation; VAS, visual analogue scale.

patients. The CCI is a method to categorize comorbidities based on the International Classification of Diseases (ICD) diagnosis codes to predict the ten-year mortality.[29] These variables were used to determine the potential presence of selection bias due to differences in frailty of the subgroups as a reason to postpone surgery instead of non-medical reasons. Time to surgery was measured as hours between time of arrival at the emergency department until start of surgery. Time of the day, moment of the week, and on-call time all concern the day surgery was performed. Pain was measured using a visual analogue scale (VAS), in which 0 is no pain and 10 is the worst pain imaginable, for pain preoperatively and on day one after surgery.

Standard antibiotic prophylaxis, 1 to 3 g of cefazolin, was administered intravenously 20 to 30 minutes preoperatively with surgery performed in laminar air flow theatres. The following prostheses and osteosynthesis systems were used: hip hemiarthroplasty (cemented (Palamed G, gentamicin impregnated cement; Heraeus, Germany), unipolar prosthesis (Mathys CCA; Mathys Bettlach, Switzerland)), total hip arthroplasty (Zimmer Biomet, USA), Femoral Neck System (DePuy Synthes, Switzerland), Dynamic Hip Screw, Cannulated Screw Fixation (DePuy Synthes, Johnson & Johnson Medical Devices, USA), and Gamma-nail (Stryker, USA).

Blood loss was extracted from the surgical record as it was noted by the operating team (including GRR and MHJV). Since previous studies have shown that accurate measurement of blood loss during surgery is difficult, the change (Δ) in the haemoglobin level, between the preoperative and the lowest haemoglobin level postoperatively (in g/l), was also used as a proxy for blood loss.[30] The Centers for Disease Control and Prevention (CDC) definition of a deep SSI was used: an infection occurring postoperatively beneath the fascia lata, combined with either purulent drainage, spontaneous wound dehiscence, fever, signs of an abscess, or localized pain.[31] Postoperative haematomas were diagnosed by inspection of the surgical incision during the daily ward rounds. For all patients, risk of development of pressure sores was assessed during admission. First, high-risk patients were identified using the Prevention and Pressure Ulcer Risk Score Evaluation (prePURSE).[32] High-risk patients underwent frequent repositioning and received pressure-reducing matresses. Second,

Table II. Perioperative variables of 1,803 included patients.

Factor	Overall (n = 1,803)	< 24 hrs (n = 1,428)	≥ 24 hrs (n = 375)	p-value
Fracture type, n (%)				
Femoral neck fracture	1,017 (56)	777 (54)	240 (64)	0.001*
Trochanteric fracture	730 (41)	601 (42)	129 (34)	0.007*
Subtrochanteric fracture	58 (3)	51 (4)	7 (2)	0.096*
Time of the day, n (%)				0.111*
Daytime (0800 to 1800 hours)	1,573 (87)	1,255 (88)	318 (85)	
Night-time (1800 to 0800 hours)	230 (13)	173 (12)	57 (15)	
Day of the week, n (%)				0.006*
Weekdays	1,296 (72)	1,005 (70)	291 (78)	
Weekends	507 (28)	423 (30)	84 (22)	
On-call time, n (%)				0.236*
Working hours	1,111 (62)	870 (61)	241 (64)	
Night-time and weekends	692 (38)	558 (39)	134 (36)	
Anaesthesia, n (%)				0.514*
Spinal (reference)	1,625 (90)	1,291 (91)	334 (90)	
General	172 (10)	133 (9)	39 (10)	
Unknown	6 (0)	4 (0)	2 (0)	

*Chi-squared test.

if patients were identified as high risk, dieticians (including GRR and MHJV) were consulted to optimize nutritional status. Daily inspection of high-risk areas was performed to quickly identify potential pressure sores. Pressure sores were scaled as follows: stage 1, intact skin with nonblanchable redness; stage 2, loss of dermis, which is presented as an superficial open ulcer; stage 3, full thickness loss of tissue; and stage 4, full thickness loss of tissue with exposed bone/tendon/muscle. Length of hospital stay was defined as the total admission duration in days, from presentation at the Emergency Department until discharge. Length of stay postoperative was the number of days a patients was admitted to the ward after surgery until discharge. Days needed to be ready for discharge were the days postoperatively actual medical treatment was needed. The difference between days ready for discharge and the postoperative length of stay was the number of days a patient waited for either placement in a rehabilitation centre, a nursing home, or additional facilities to either return home or return to semi-independent nursing homes.

Statistical analysis. Castor EDC, a cloud-based clinical data management platform (Castor EDC, the Netherlands), was used to store data anonymously. Statistical analysis was performed using Stata version 14.0 (StataCorp, USA). Categorical variables are presented as frequencies and percentages, whereas continuous variables are presented as means with a standard deviation (SD) in case of normal distribution, or as median with an interquartile range (IQR) in case of skewed distribution. All statistical tests were two-sided with a significance level of 5%. Statistical tests used were chi-squared test, independent-samples *t*-test, Mann-Whitney U test, Kruskal-Wallis, and linear regression analysis. Patients were divided into two groups: patients who had surgery < 24 hours and patients who had surgery ≥ 24 hours after admission. Subgroup analysis was performed for five timeframes (TFs): zero to 12, > 12 to 24, > 24 to 36, > 36 to 48, and ≥ 48 hours. Univariate analysis was performed to assess the influence of time to surgery on clinical outcomes such as blood loss, deep SSI, pneumonia, delirium, pressure sores, urinary tract infections, reoperations, readmission, and 30-day mortality.

Ethical approval. This observational study was approved by the local Medical Research Ethics Committee (Maasstad Hospital, Rotterdam, the Netherlands; Netherlands Trial Register, nr NL 8313). All protocols were in accordance with the Declaration of Helsinki.[33] Since no changes were made to the standard practice of care and patients were not traceable due to an anonymized database, the local ethics committee decided that patients' consent to review their medical records was not required. No external funding was received for this study and no conflicts of interest need to be reported.

Results

Primary analysis. Table I shows baseline characteristics of enrolled patients. Patients who had surgery within 24 hours after admission (n = 1,428) were significantly younger (mean 82 years (SD 8) vs 83 years (SD 8); p = 0.034, independent-samples *t*-test), had an ASA grade of 1 to 2 more often (31% (n = 441) vs 25% (n = 94); p = 0.028, chi-squared test), had a lower mean CCI (5.0 (SD 1.7) vs 5.3 (SD 1.7); p = 0.016, Mann-Whitney U test), less frequently had a medical history of myocardial infarction (61% (n = 870) vs 64% (n = 240); p = 0.037, chi-squared test), and less frequently used vitamin K antagonist (12% (n = 174) vs 22% (n = 84); p < 0.001, chi-squared test), but more often used thrombocyte aggregation inhibitors (37% (n = 524) vs 30% (n = 114); p = 0.023, chi-squared test) compared with patients who had surgery ≥ 24 hours after admission (n = 375). No difference in residential status was present.

Of the patients who had surgery ≥ 24 hours after admission, 64% (n = 240) had a femoral neck fracture and 34% (n = 34) had an intertrochanteric fracture (p = 0.002, chi-squared test) (Table II). Patients admitted during weekends also more frequently underwent surgery within 24 hours (30% (n = 423) vs 22% (n = 84); p = 0.006, chi-squared test). No significant differences in any postoperative complication were found

Table III. Clinical outcomes of 1,803 included patients.

Factor	Overall (n = 1,803)	< 24 hrs (n = 1,428)	≥ 24 hrs (n = 375)	p-value
Median blood loss, ml (IQR)	150 (50 to 200)	150 (50 to 200)	150 (50 to 200)	0.668*
Mean ΔHb, g/l (SD)	25.2 (16.2)	25.2 (16.2)	25.2 (16.2)	0.796*
Packed cell supplementation, n (%)	360 (20)	298 (20)	71 (19)	0.574†
Haematoma, n (%)	104 (6)	83 (6)	21 (6)	0.875†
Median VAS pain day 1 postoperative (IQR)	3 (1 to 4)	3 (2 to 4)	3 (1 to 4)	0.807*
Deep SSI, n (%)	19 (1)	14 (1)	5 (1)	0.551†
Pneumonia, n (%)	155 (9)	116 (8)	39 (10)	0.162†
Delirium, n (%)	311 (17)	245 (17)	66 (18)	0.840†
Median DOS score (IQR)	8 (6 to 10)	8 (6 to 10)	8 (6 to 10)	0.682*
Pressure ulcer, n (%)	78 (4)	59 (4)	19 (5)	0.428†
Stage 1	43 (55)	36 (61)	7 (37)	0.230†
Stage 2	30 (39)	19 (32)	11 (58)	
Stage 3	4 (5)	3 (5)	1 (5)	
Stage 4	1 (1)	1 (2)	0 (0)	
Urinary tract infection	153 (8)	124 (9)	29 (8)	0.557
Catheter placement, n (%)	1,555 (86)	1,234 (86)	321 (86)	0.684†
Median catheter removal, days postoperative (IQR)	1 (1 to 2)	1 (1 to 2)	1 (1 to 2)	0.297*
Reoperation				
Reoperation for deep SSI, n (%)	19 (1)	14 (1)	5 (1)	0.551†
Reoperation for luxation of prosthesis, n (%)	12 (1)	9 (1)	3 (1)	0.719†
Median length of stay, days (IQR)	6 (4 to 9)	6 (4 to 9)	7 (5 to 10)	0.001*
Median ready for discharge, days (IQR)	4 (3 to 5)	3 (3 to 5)	4 (3 to 6)	< 0.001*
Median length of stay postoperative, days (IQR)	5 (3 to 8)	5 (3 to 8)	5 (3 to 8)	0.185*
Discharge destination, n (%)				0.107†
Home	231 (13)	197 (14)	34 (9)	
Semi-independent nursing home	324 (18)	253 (18)	71 (19)	
Nursing home/rehabilitation centre	1193 (66)	936 (66)	257 (69)	
New to nursing home	786 (44)	597 (42)	189 (50)	0.003†
Readmission, n (%)	36 (2)	29 (2)	7 (2)	0.840†
Deceased during admission, n (%)	55 (3)	42 (2)	13 (3)	0.598
30-day mortality, n (%)	157 (9)	124 (9)	33 (9)	0.943†

*Independent-samples *t*-test.
†Chi-squared test.
DOS, delirium observational screening; Hb, haemoglobin; IQR, interquartile range; SD, standard deviation; SSI, surgical site infection; VAS, visual analogue scale.

between both groups (Table III), nor in postoperative reported pain score (median VAS 3 (IQR 2 to 4) vs 3 (IQR 1 to 4); p = 0.807, independent-samples *t*-test). Patients who had surgery ≥ 24 hours after admission did have a longer total length of hospital admission compared to patients who had surgery < 24 hours after admission (median 6 days (IQR 4 to 9) vs 7 days (IQR 5 to 10); p = 0.001, independent-samples *t*-test), without a difference in postoperative length of hospital stay. Patients who had surgery < 24 hours after admission were ready for discharge more quickly (3 (IQR 3 to 5) days vs 4 (IQR 3 to 6) days; p < 0.001, independent-samples *t*-test), and patients who had surgery ≥ 24 hours after admission were more frequently newly discharged to a nursing home (50% (n = 189) vs 42% (n = 597); p = 0.003, chi-squared test). No differences in readmission or 30-day mortality rates were found.

Subgroup analysis. In the subgroup analysis using time frames (TFs) of 12 hours, ASA grades of 3 and 4 were found more frequently in TF 24 to 36 hours compared to TF zero to 12 hours (78% (n = 163) vs 66% (n = 295); p = 0.002, chi-squared test) and TF 12 to 24 hours (78% (n = 163) vs 71% (n = 692); p = 0.031, chi-squared test). The median glomerular filtration rate (GFR) decreased significantly with increasing time to surgery, from 70 ml/min/1.73 m^2 (IQR 54 to 82) in TF zero to 12 hours to 68 ml/min/1.73 m^2 (IQR 48 to 80) in TF 12 to 24 hours to 64 ml/min/1.73 m^2 (IQR 51 to 77) in TF 24 to 36 hours (p = 0.034, linear regression analysis) (Table IV and Table V).

In contrast to the primary analysis, subgroup analysis showed a gradual increase of the number of pressure ulcers with increasing time to surgery, ranging from 3% in TF zero to 12 hours to 11% in TF > 48 hours (Table VI). No association between stages of pressure ulcers and increasing time to surgery was observed. Urinary tract infections occurred more frequently if time to surgery was longer than 48 hours, i.e. 18% (n = 5) versus an overall occurrence of 8% (n = 153) (p = 0.002, chi-squared test). No statistical differences in postoperative days until catheter removal were present. No differences in reported postoperative pain scores were found. Total length of hospital stay unavoidably was longer when time to surgery increased (zero to 12 hours: 5 days (3 to 8); 12 to 24 hours: 6 days (4 to 9); 24 to 36 hours: 7 days (4 to 9); 36 to 48 hours: 7 days (5 to 10); and > 48 hours: 9 days (8 to 11); p < 0.001, linear regression analysis). No significant difference was found

Table IV. Baseline characteristics of 1,803 included patients.

Factor	Overall	0 to 12 hrs	12 to 24 hrs	24 to 36 hrs	36 to 48 hrs	> 48 hrs	p-value
Total, n (%)	1,803 (100)	448 (25)	980 (54)	209 (12)	138 (8)	28 (2)	N/A
Mean age, yrs (SD)	83 (8)	82 (8)	82 (8)	84 (8)	83 (8)	83 (8)	0.198*
Female, n (%)	1,265 (70)	302 (67)	696 (71)	148 (71)	98 (71)	21 (75)	0.668†
BMI, n (%)							0.621†
< 18.5 kg/m^2	95 (5)	22 (5)	55 (6)	8 (4)	8 (6)	2 (7)	
18.5 to 30 kg/m^2	1,078 (60)	264 (59)	576 (59)	129 (62)	91 (66)	18 (64)	
> 30 kg/m^2	108 (6)	22 (5)	68 (7)	9 (4)	6 (4)	3 (11)	
Unknown	522 (29)	140 (31)	281 (28)	63 (30)	33 (24)	5 (18)	
Comorbidities, n (%)							
Dementia	469 (26)	123 (27)	256 (26)	62 (30)	24 (17)	4 (14)	0.055†
Cardiovascular disease	1,110 (62)	258 (58)	612 (62)	127 (61)	92 (67)	21 (75)	0.135†
Myocardial infarction	137 (8)	28 (6)	71 (7)	26 (12)	10 (7)	2 (7)	0.080†
Cerebrovascular accident	228 (13)	43 (10)	130 (13)	30 (14)	21 (15)	4 (14)	0.235†
COPD	221 (12)	53 (12)	120 (12)	31 (15)	16 (12)	1 (4)	0.496†
Antithrombotics, n (%)							
No antithrombotics	914 (51)	250 (56)	487 (50)	95 (45)	68 (49)	14 (50)	0.112†
Vitamin K antagonist	258 (14)	39 (9)	135 (14)	46 (22)	33 (24)	5 (18)	< 0.001†
Thrombocyte aggregation inhibitor	638 (35)	163 (36)	361 (37)	70 (33)	37 (27)	7 (25)	0.127†
Residential status, n (%)							0.183†
Home	1,222 (68)	281 (63)	676 (69)	145 (69)	99 (72)	21 (75)	
Semi-independent nursing home	155 (9)	45 (10)	74 (8)	19 (9)	15 (11)	2 (7)	
Nursing home	426 (23)	122 (27)	230 (23)	45 (22)	24 (17)	5 (18)	
Median NHFS (IQR)	5 (4 to 6)	5 (4 to 6)	5 (4 to 6)	5 (4 to 6)	5 (4 to 6)	4 (4 to 5)	0.623‡
ASA grade, n (%)							0.016†
1 to 2	535 (30)	135 (34)	228 (29)	46 (22)	43 (31)	5 (18)	
3 to 4	1,268 (70)	295 (66)	692 (71)	163 (78)	95 (69)	23 (82)	
Mean CCI (SD)	5.1 (1.7)	5.0 (1.7)	5.1 (1.7)	5.3 (1.5)	5.3 (1.8)	5.2 (1.9)	0.100‡
Mean preoperative Hb level, g/L (SD)	140.4 (18.0)	140.4 (18.0)	140.4 (18.0)	142.2(18.0)	12.7 (1.3)	142.2 (16.2)	0.213*
Median preoperative GFR, ml/min/1.73 m^2 (IQR)	68 (50 to 80)	70 (54 to 82)	68 (48 to 80)	64 (51 to 77)	69 (52 to 81)	68 (51 to 79)	0.033*
FICB, n (%)	299 (17)	72 (16)	161 (16)	42 (20)	21 (15)	3 (11)	0.586†
Unknown	1 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Median VAS pain preoperative (IQR)	4 (3 to 5)	4 (3 to 5)	4 (3 to 5)	4 (3 to 5)	4 (3 to 5)	4 (3 to 6)	0.751*

*Linear regression.
†Chi-squared test.
‡Kruskal-Wallis.
ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; COPD, chronic obstructive pulmonary disease; FICB, fascia iliaca compartment block; GFR, glomerular filtration rate; Hb, haemoglobin; IQR, interquartile range; N/A, not applicable; NHFS, Nottingham Hip Fracture Score; SD, standard deviation; VAS, visual analogue scale.

in postoperative length of hospital stay. There was, however, a significant difference in the number of days needed for patients to be ready for discharge (zero to 12 hours: 3 days (2 to 4); 12 to 24 hours: 4 days (3 to 5); 24 to 36 hours: 4 days (3 to 6); 36 to 48 hours: 4 days (4 to 6); and > 48 hours: 6 days (4 to 8); p < 0.001, linear regression analysis). Patients were discharged newly to a nursing home more frequently with increasing time to surgery. However, if time to surgery was > 48 hours, this proportion was significantly lower (40% (n = 180), 43% (n = 417), 53% (n = 110), 51% (n = 70), and 32% (n = 9) at zero to 12, 12 to 24, 24 to 36, 36 to 48, and > 48 hours, respectively; p = 0.008, chi-squared test). No differences in readmission or 30-day mortality rates were found.

Discussion

Determining optimal time to surgery in geriatric hip fracture patients remains a point of discussion in daily practice.[8,12–14,34] If prolonged time to surgery is necessary to optimize the patient's physiology, postponement of surgery might improve the final outcome.[5-8,16-18,20,22-26] A large previous cohort study concluded that prolonged time to surgery was associated with higher 30-day and one-year mortality rates.[35] However, that study does not exclude patients who need preoperative optimization.[35] Thus, to optimize the more frail patients preoperatively more time would have been needed. The results of that study do show this, as patients with longer time to surgery have higher CCI scores.[35] To avoid this problem and assess the influence of time

Table V. Perioperative characteristics of 1,803 included patients.

Factor	Overall	0 to 12 hrs	12 to 24 hrs	24 to 36 hrs	36 to 48 hrs	> 48 hrs	p-value
Total, n (%)	1,803 (100)	448 (25)	980 (54)	209 (12)	138 (8)	28 (2)	N/A
Fracture type, n (%)							
Femoral neck fracture	1,017 (56)	216 (48)	561 (57)	128 (61)	90 (65)	22 (78)	< 0.001*
Trochanteric fracture	730 (41)	210 (47)	391 (40)	75 (36)	48 (34)	6 (22)	0.004*
Subtrochanteric fracture	58 (3)	22 (5)	29 (3)	6 (3)	1 (1)	0 (0)	0.088*
Time of the day, n (%)							< 0.001*
Daytime (0800 to 1800 hours)	1,573 (87)	337 (75)	918 (94)	156 (75)	136 (99)	26 (93)	
Night-time (1800 to 0800 hours)	230 (13)	111 (25)	62 (6)	53 (25)	2 (1)	2 (7)	
Day of the week, n (%)							0.039*
Weekdays	1,296 (72)	306 (68)	699 (71)	160 (77)	107 (78)	24 (86)	
Weekends	507 (28)	142 (32)	281 (29)	49 (23)	31 (22)	4 (14)	
On-call time, n (%)							< 0.001*
Working hours	1,111 (62)	218 (49)	652 (67)	113 (54)	105 (76)	23 (82)	
Night-time and weekends	692 (38)	230 (51)	328 (33)	96 (46)	33 (24)	5 (18)	
Anaesthesia, n (%)							0.703*
Spinal (reference)	1,625 (90)	405 (91)	886 (91)	185 (89)	122 (89)	27 (96)	
General	172 (10)	40 / 445 (9)	93 (9)	23 (11)	15 (11)	1 (4)	
Unknown	6 (0)	3 (0)	1 (0)	1 (0)	1 (0)	0 (0)	

*Chi-squared test.
Hb, haemoglobin; N/A, not applicable.

to surgery as an isolated variable, we excluded all patients with a medical indication to postpone surgery. In the study group, 14% of the patients (n = 296) had postponement of surgery for medical reasons and were therefore excluded.

Patients with a longer delay to surgery more frequently had a higher ASA grade. This higher ASA grade could suggest selection bias. This can be surmized by differences in use of oral anticoagulants between the study groups. We found that patients using vitamin K antagonists had a longer interval to surgery, but for patients using thrombocyte aggregation inhibitors an increased delay was not found. A previous meta-analysis showed findings which concur with the findings in our study. In this meta-analysis, both DOAC and vitamin K antagonists were associated with longer time to surgery.[36] Vitamin K antagonist use was associated with a 17-hour surgical delay, and DOAC use was associated with a 16-hour delay compared with patients not on an oral anticoagulant.[36] Patients using DOAC were excluded in our study cohort, but a similar postponement of surgery was found in patients using vitamin K antagonists. The differences in use of oral anticoagulants could have induced the higher ASA grade in patients who had longer time to surgery. Despite the difference found in ASA grade, no differences were present in NHFS, CCI, and comorbidities between the five subgroups. Although omitted from the ASA grade, the systemic impact of acute pathology, such as proximal femoral fractures, is included in surgical risk scores such as the Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (POSSUM)[37–39] and the NHFS.[3,29] Of these preoperative assessment scales, the NHFS shows the most promising results in predicting 30-day mortality in hip fracture patients. The CCI is considered most reliable to quantify frailty.[29,40] These two variables were used to determine whether potential selection bias due to differences in frailty of the subgroups was present despite the used exclusion criteria, and therefore whether frailty was reason for postponing surgery instead of non-medical reasons. Since the NHFS, CCI, and comorbidities showed no statistically significant differences between the various TFs, frailty is therefore assumed to be equally distributed in the entire cohort and not a reason to postpone surgery.

We also found that patients with femoral neck fractures, i.e. intracapsular fractures, more often had surgery after 24 hours, compared to those with trochanteric fractures. This difference can be attributed to various reasons. First, femoral neck fractures, i.e. intracapsular fractures, in the elderly are mostly treated with an arthroplasty and trochanteric fractures generally by osteosynthesis. Since an arthroplasty usually takes longer than osteosynthesis, it is less likely to be accommodated at the end of an elective operating list and less suitable to be performed during evening shifts when operating theatre capacity is limited. A second factor might be that well trained surgical residents are allowed to perform osteosynthesis for a trochanteric fracture unsupervised, whereas hip arthroplasty is more likely to be performed by an orthopaedic trauma surgeon or under their direct supervision. Finally, the sense of urgency between both procedures might differ for at least two reasons: functional outcome of arthroplasty surgery is not considered time dependent, whereas timely fracture reduction and fixation might optimize microcirculation in the fracture zone and thus contribute to successful joint preservation;[41] and trochanteric fractures are associated with substantial preoperative blood loss due to their extracapsular location, whereas blood loss in the intracapsular femoral neck fractures might be limited.[20]

To determine which patients can undergo hip fracture surgery within 48 hours from admission, complications associated with longer time to surgery should be weighted. Previous studies concluded that time to surgery is positively associated with the risk for pneumonia, pressure ulcers, and delirium,[5-7,16-18] and an increase in length of hospital stay and even mortality.[20] However, these studies also included patients in need of preoperative optimization, therefore enrolling more vulnerable patients in groups

Table VI. Clinical outcomes of 1,803 included patients.

Factor	Overall	0 to 12 hrs	12 to 24 hrs	24 to 36 hrs	36 to 48 hrs	> 48 hrs	p-value
Total, n (%)	1,803 (100)	488 (25)	980 (54)	209 (12)	138 (8)	28 (2)	N/A
Median blood loss, ml (IQR)	150 (50 to 200)	150 (75 to 200)	100 (50 to 200)	150 (50 to 200)	150 (100 to 200)	100 (50 to 350)	0.883*
Mean ΔHb, g/l (SD)	25.2 (16.2)	25.2 (14.4)	25.2 (16.2)	27.0 (18.0)	23.4 (14.4)	21.6 (19.8)	0.354*
Packed cell supplementation, n (%)	360 (20)	103 (23)	186 (19)	46 (22)	20 (15)	5 (18)	0.173†
Haematoma, n (%)	104 (6)	31 (7)	52 (5)	7 (3)	12 (9)	2 (7)	0.199†
Median VAS pain day 1 postoperative (IQR)	3 (1 to 4)	3 (2 to 4)	3 (1 to 4)	3 (1 to 4)	3 (1 to 4)	3 (2 to 4)	0.743*
Deep SSI, n (%)	19 (1)	7 (2)	7 (1)	2 (1)	3 (2)	0 (0)	0.383†
Pneumonia, n (%)	155 (9)	33 (7)	83 (8)	18 (9)	17 (12)	4 (14)	0.346†
Delirium, n (%)	311 (17)	79 (18)	166 (17)	31 (15)	28 (20)	7 (25)	0.551†
Median DOS score (IQR)	8 (6 to 10)	8 (6 to 10)	8 (6 to 10)	8 (7 to 10)	8 (5 to 10)	9 (8 to 10)	0.373*
Pressure ulcer, n (%)	78 (4)	15 (3)	44 (4)	3 (1)	13 (9)	3 (11)	0.002†
Stage 1	43 (55)	9 (60)	27 (61)	1 (33)	5 (38)	1 (33)	0.226†
Stage 2	30 (39)	5 (33)	14 (32)	2 (67)	8 (62)	1 (33)	
Stage 3	4 (5)	0 (0)	3 (7)	0 (0)	0 (0)	1 (33)	
Stage 4	1 (1)	1 (7)	0 (0)	0 (0)	0 (0)	0 (0)	
Urinary tract infection	153 (8)	22 (5)	102 (10)	17 (8)	7 (5)	5 (18)	0.002†
Catheter placement, n (%)	1,555 (86)	376 (84)	858 (88)	180 (86)	119 (86)	22 (79)	0.305†
Median catheter removal, days postoperative (IQR)	1 (1 to 2)	1 (1 to 2)	1 (1 to 2)	1 (1 to 2)	1 (1 to 2)	2 (1 to 3)	0.520*
Reoperation							
Reoperation for deep SSI, n (%)	19 (1)	7 (2)	7 (1)	2 (1)	3 (2)	0 (0)	0.383†
Reoperation for luxation of prosthesis, n (%)	12 (1)	3 (1)	6 (1)	1 (1)	2 (2)	0 (0)	0.805†
Median length of stay, days (IQR)	6 (4 to 9)	5 (3 to 8)	6 (4 to 9)	7 (4 to 9)	7 (5 to 10)	9 (8 to 11)	< 0.001*
Median ready for discharge, days (IQR)	4 (3 to 5)	3 (2 to 4)	4 (3 to 5)	4 (3 to 6)	4 (4 to 6)	6 (4 to 8)	< 0.001*
Median length of stay postoperative, days (IQR)	5 (3 to 8)	5 (3 to 8)	5 (3 to 8)	6 (3 to 8)	5 (3 to 8)	7 (4 to 9)	0.955*
Discharge destination, n (%)							0.076†
Home	231 (13)	58 (13)	139 (14)	17 (8)	15 (11)	2 (7)	
Semi-independent nursing home	324 (18)	83 (19)	170 (17)	35 (17)	25 (18)	11 (39)	
Nursing home/ rehabilitation centre	1,193 (66)	297 (66)	639 (65)	152(73)	91 (66)	14 (50)	
New to nursing home	786 (44)	180 (40)	417 (43)	110 (53)	70 (51)	9 (32)	0.008†
Readmission, n (%)	36 (2)	9 (2)	20 (2)	3 (1)	4 (3)	0 (0)	0.828†
Deceased during admission, n (%)	55 (3)	10 (2)	32 (3)	5 (2)	7 (5)	1 (4)	0.492†
30-day mortality, n (%)	157 (9)	41 (9)	83 (8)	19 (9)	12 (9)	2 (7)	0.989†

*Linear regression.
†Chi-squared test.
DOS, delirium observational screening; Hb, haemoglobin; IQR, interquartile range; SD, standard deviation; SSI, surgical site infection; VAS, visual analogue scale.

with longer time to surgery.[21] Mortality rates, however, did not increase if longer time to surgery was necessary to optimize preoperative cardiac or pulmonary conditions.[16] In our study, patients requiring preoperative optimization were excluded to prevent this confounder. We observed that a longer delay to surgery was associated with more urinary tract infections and pressure ulcers, in particular when surgery was performed ≥ 48 hours after admission. A previous study found a statistically significant association between the number of days catheters were in situ and development of urinary tract infections.[42] It also showed that 75% of the urinary tract infections in hospitals were catheter-associated.[42] We found no differences in postoperative days of catheter use, only the preoperative duration differed. We found no differences in the presence of a catheter during admission, and also no difference in these variables in the patients who developed a urinary tract infection. Catheter use and time to surgery could therefore be confounding variables. No differences in 30-day mortality rates were found.

One clinically relevant finding was the longer length of hospital stay in the group of patients with longer time to surgery.

This finding was also present for the five TFs. Length of stay was longer when time to surgery increased and since no difference was found in postoperative length of stay, the added time in the hospital was due to the surgical postponement. Additionally, we found that longer time to surgery was associated with longer time required to prepare patients for discharge. This, combined with a higher percentage of patients newly discharged to a nursing home facility or rehabilitation centre, could be another explanation for the prolonged length of hospital stay, despite the equal postoperative length of stay.

Our study has a number of strengths and limitations. This large, prospective study provides insight into the negative consequences of surgical postponement due to non-medical reasons on clinical outcomes in geriatric hip fracture patients in two high-volume centres. Exclusion of all patients with a medical indication to postpone surgery can be considered a selection bias, but it strengthens the recommendation to avoid surgical postponement for non-medical reasons only. Extrapolation of these results to more frail patients with suspected worse outcome regarding mortality and complications should thus be done with caution. Another drawback is the time to surgery. It has been measured as the period between arrival at the surgical ward until start of surgery. Ideally, the prehospital time should be taken into account as well. This omission might have led to both under- or overestimation of the negative effect of the definition of time to surgery as used in this study. We did aim to register the prehospital time by registering the time of the trauma. This exact value, however, was unknown for the majority (> 80%) of our patients. Last, in the two participating centres no dedicated trauma list was available during daytime.

In conclusion, in this selected study population of patients whose surgery was postponed due to non-medical reasons, a longer time to surgery (> 48 hours) was associated with the development of more pressure ulcers and urinary tract infections. No association was found between time to surgery and development of deep SSIs, reoperation, or delirium. We also found a longer total length of hospital stay with increasing time to surgery, but no difference in postoperative hospital stay was found. An association between time to surgery and 30-day mortality could not be demonstrated. We therefore conclude that it is acceptable to treat this selected patient population within a window of 48 hours after admission.

Take home message

- Time to surgery > 48 hours after admission is associated with a higher percentage of postoperative decubital ulcers and urinary tract infections.
- Longer time to surgery was associated with longer hospital admission, but not with longer postoperative hospital stay.
- No association was found between time to surgery and 30-day mortality rates.

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