International Orthopaedics (2019) 43:441–448
https://doi.org/10.1007/s00264-018-3936-5

ORIGINAL PAPER

Reasons for delaying surgery following hip fractures and its impact on one year mortality

Alejandro Lizaur-Utrilla[1,2] · Blanca Gonzalez-Navarro[1] · Maria F. Vizcaya-Moreno[3] · Francisco A. Miralles Muñoz[1] · Santiago Gonzalez-Parreño[1] · Fernando A. Lopez-Prats[2]

Received: 10 January 2018 / Accepted: 5 April 2018 / Published online: 9 May 2018

Abstract

Purpose The purposes of this study were to identify the reasons for delayed surgery following hip fractures and analyze the impact of these reasons on 1-year mortality.

Methods A prospective cohort study of 1234 patients with mean age of 83.1 (range 65–92, SD 8.0) who underwent hip fracture surgery compared three subgroups: (1) surgery within two days from admission (609 patients); (2) delayed surgery for medical reasons (286); and (3) delayed surgery for organizational causes (339). Medical reason was defined as the need of medical optimization of the patient prior to surgery. Pre-operative assessment was performed by the American Society of Anesthesiologists (ASA) score, Charlson Comorbidity Index (CCI), Hodkinson mental status, Katz index for activities of daily living, and Short-Form (SF-12) questionnaire. Univariate analyses were used (chi-square and Fisher exact or Mantel-Haenszel tests for categorical data, and variance analysis, Student *t* test, or Mann-Whitney *U* test for continuous data). Logistic regression models were used for influence of variables on complications and one year mortality.

Results There were no significant differences in complications or one year mortality rates between patients with surgery within two days and those with delayed surgery for medical reasons. However, the patients with delayed surgery for organizational causes had significant higher rates of both complications and one year mortality compared to the other two groups ($p = 0.001$).

Conclusions This study suggests that waiting time for hip fracture surgery more than two days was not associated with higher complication or mortality rate if waiting was to stabilize patients with active comorbidities at admission, compared to stable patients at admission with early surgery. Although early surgery within two days from admission is desirable for stable patients at admission, in patients with complex comorbidities, the surgery should be performed once they are optimized. However, the patients with delayed surgery for organizational reasons had a significant higher rate of post-operative complications and one year mortality compared to the other two groups.

Keywords Hip fracture · Delayed surgery · Early surgery · Medical reasons · Organizational reasons

Introduction

Hip fractures in elderly patients are currently a serious medical, social, and economic healthcare problem and are related to high morbidity and mortality. In the literature, one year mortality has been estimated to range from 14 to 36% [1]. Several studies have suggested that surgery delayed longer than 48 hour may lead to increased risk of pressure sores, major medical complications, surgical site infection, decreased patient outcome measures, and both in-hospital and one year mortality [2–4]. Based on this, a stringent timeline for surgery within 48 hours after hip fracture has been advocated by some clinical guidelines and the rate of surgeries performed within that time has been considered as a quality indicator by some healthcare administrators [5]. However, other studies reported no increased complications or one year mortality after delay more than 48 hours [6–8]. Thus, the time to surgery that should be considered to represent an unacceptable delay for hip fracture surgery is still a debate in the literature.

✉ Alejandro Lizaur-Utrilla
lizaur1@telefonica.net

1 Orthopaedic Surgery, Elda University Hospital, Miguel Hernandez University, Ctra Elda-Sax s/n, 03600 Elda, Alicante, Spain

2 Traumatology and Orthopaedia, Miguel Hernandez University, Elche, Alicante, Spain

3 Clinical Research Group, Faculty of Health Sciences, University of Alicante, Alicante, Spain

On the other hand, although surgery for hip fracture is desirable to be performed as soon as possible, this early surgery may not always be feasible due to patient-related [2] or organizational reasons [9, 10]. An important limitation of the literature is the lack of information on the reasons for surgery delay. In addition, most studies on the timing of surgery in patient with hip fracture considered that each group, early or delayed surgery, was homogeneous and the authors did not report details on the reasons that delayed surgery. Few studies have focused on the reasons for surgical delay [11, 12]. Some authors have suggested that patients with medically necessary delays may be less likely to die with longer wait times than if they received early surgery [7, 11, 13]. To our knowledge, no studies have analyzed the additive effect of the delay reasons on mortality following hip fractures.

The purposes of this study were to identify the reasons for delayed surgery following hip fractures and analyze the impact of these reasons on one year mortality.

Material and methods

A prospective cohort study was approved by our institutional review board, and informed consent was not required because this was considered service evaluation. The study population consisted in consecutive patients with hip fractures underwent surgery at our center between January 2011 and December 2016. The inclusion criteria were patients aged 65 years or older. The exclusion criteria were previous hip fracture history, multiple fractures requiring surgery, diagnostic of cancer at admission or pathological fracture, and periprosthetic fracture. Patients who received total hip replacement were excluded because our indication for this procedure was patient younger than 70 with good healthy status, and this could be a bias on patient selection. Patients who received conservative treatment, usually ASA-V, or who died before operative treatment were also excluded. For this study, patients with hip fracture occurred more than 24 hours before admission were not included in order to give all participants the same probability of exposure to the timing of surgery and avoid any kind of time-related bias.

Our centre is a regional university hospital of the national public health system with an orthopaedic surgery department that provides cares for patients with acute injuries. Our treatment strategy for hip fracture was to perform surgery as early as possible. Time to surgery was defined as the days from admission to when surgery was performed. Delayed surgery was defined as the operation performed later than two days after admission.

The patients who had surgery delay were categorized into those due to medical reasons and those due to organizational reasons. The medical reason was defined [7] as the need of medical optimization of the patient to judge of the internist or anesthesiologist, including evaluation or treatment of acute medical condition at admission, such as pneumonia, uncontrolled heart condition, severe electrolyte imbalance, severe exacerbation of chronic disease (e.g., cardiopulmonary, hemodialysis), or antiplatelet therapy reversal. Other anticoagulant drugs such as aspirin or vitamin K antagonists, uncontrolled diabetes mellitus, or uncomplicated urinary tract infection were not causes for surgical delay. The organizational reason for delayed surgery was defined [11] when there were no active medical problems, such as admission on weekend or holidays, operating room or surgeon not available, unavailability of operating room time, waiting medical consultation for chronic conditions without exacerbation, or waiting laboratory results.

Evaluations

Patients were assessed pre-operatively and post-operatively at six weeks, and then every three months with a minimum follow-up of 12 months unless death occurred before that. If the patient did not return for examination, their families were interviewed by telephone.

The exposure of interest was the reason for surgery delay more than two days as mentioned above. The primary outcome was one year mortality after surgery of the fracture. Mortality after discharge was assessed by our institutional register. In addition, our centre is a public hospital and its administration database is linked to all primary healthcare centres, remaining hospitals of our community, and the national mortality register. The secondary outcomes were rate of major complication [5] including wound infection, deep vein thrombosis or thromboembolism, cerebrovascular accident, myocardial infarction, congestive heart failure, and pneumonia.

A standardized protocol for co-management of these patients between orthopaedic surgeons and a specific team of internists was used at our hospital from admission, as we had previously published [14]. At the admission, routine evaluation included hip and chest radiographs, electrocardiography, laboratory data, and clinical assessment by a surgeon, internist, and anesthesiologist. Pre-operative stabilization, suitability of previous medical treatments, and clinical control were performed by internists from admission to discharge.

Health status was pre-operatively assessed by the American Society of Anesthesiologists (ASA) score [15] as dichotomous variable (I–II low risk, III–IV high risk) and Charlson Comorbidity Index (CCI) [16] categorized as dichotomous variable (0–2 points for low mortality risk, and 3 or more points for high risk). Mental status at admission was measured by the Hodkinson's abbreviated mental test 0–10 score [17], where 6 or less suggested dementia. Preinjury physical function was assessed using the Katz index [18] for activities of daily living (ADL), where full independence was defined as the ability to do all six ADL without assistance, partial dependence as the ability to do four or five activities without assistance, and total dependence as the ability to do three activities or fewer without assistance. Pre-injury quality of life was assessed by the Short-Form (SF-12) questionnaire [19] (physical and mental components measured independently), transformed into 0–100 scale, and where lower score indicated worse outcome.

Statistical analysis

A posteriori power analysis of the study was performed in relation to the differences of one year mortality between groups. Considering a minimum size of 286 patients in each group, an effect size of $d = 1.81$ and a power of 0.83 for alpha 5% were obtained, which were considered adequate.

Statistical analyses were conducted with IBM-SPSS v. 15 software. Normal distribution was assessed by the Kolmogorov-Smirnov test. For univariate analysis, categorical variables were analyzed by the chi-square test or non-parametric Fisher exact and Mantel-Haenszel tests. For continuous variables, variance analysis, Student *t* test, or Mann-Whitney *U* test were used. A multivariate model was conducted by logistic regression models, using the variables that showed any difference in univariate analysis ($p < 0.25$) as independent variables and the presence of complications and 1-year mortality as dependent variables. An odds ratio (OR) with 95% confidence interval (CI) for risk factors was used. A *p* value of less than 0.05 was considered significant in all tests.

Results

Over the study period, there were 1324 hip fracture admissions in patients with mean age of 83.1 (range, 65–92; SD, 8.0). All patients were admitted on the same day of injury. Of them, 91 (6.8%) were excluded for study, 27 (2.0%) had non-surgical treatment, 49 other (3.6%) died during their hospital stay, and 15 (1.1%) had other exclusion criteria. The remaining 1234 patients were study cohort. Of them, 609 (49.3%) received surgery within two days from admission (non-delay group) and 286 (23.2%) had delayed surgery due to medical reasons and 339 (27.5%) due to organizational reasons according to our criteria. Baseline patient characteristics are shown in Table 1. As expected, there were significant differences in ASA and Charlson scores ($p = 0.001$) between the medical delay reasons group and the other groups. Activities of daily living (Katz index) were significantly better in the organizational delay reasons group ($p = 0.001$).

The mean time to surgery was 4.1 (range, 3–20; median, 3.7) days in patients in the medical delay reasons group, and 3.9 (range, 3–5; median, 3.2) days in the organizational delay reasons group. The reasons of surgical delay are shown in Table 2. The most common reasons for medical delay were exacerbation of a chronic chest condition (23.8%), antiplatelet therapy reversal (23.1%), and correctable cardiac arrhythmia (14.73%), and for organizational delay were unavailable

Table 1 Baseline patient characteristics

	No delay $n = 609$	Medical delay $n = 286$	Organizational delay $n = 339$	*p* value
Age (year)	83.5 (8.1)	83.3 (7.9)	82.4 (7.6)	n.s.
Female/male	438/171	185/101	237/102	n.s.
BMI (kg/m2)	30.4 (5.7)	30.2 (4.2)	29.4 (6.7)	n.s.
ASA I–II/III–IV	335/274	72/214	186/153	0.001
Charlson index	2.1 (1.3)	3.3 (1.4)	2.1 (0.9)	0.001
Dementia	14.2%	13.9%	12.0%	n.s.
Katz index	4.1 (1.4)	4.3 (1.6)	4.9 (1.4)	0.001
SF12-physical	30.3 (16.2)	27.6 (20.1)	30.1 (14.3)	n.s.
SF12-mental	27.5 (13.2)	24.5 (14.2)	26.5 (11.7)	n.s.
Trochanteric fract	329 (54.0%)	162 (56.6%)	181 (53.4%)	n.s.
Sliding hip screw	321 (97.5%)	158 (97.5%)	175 (96.6%)	
Trochanteric nail	8 (2.5%)	4 (2.5%)	6 (3.4%)	
Subtrochanteric fract	42 (6.9%)	21 (7.3%)	22 (6.5%)	
Sliding hip screw	1 (2.4%)	0	0	
Trochanteric nail	41 (97.6%)	21 (100%)	22 (100%)	
Cervical fract	238 (39.1%)	103 (36.0%)	136 (40.1%)	n.s.
Sliding hip screw	2 (0.8%)	1 (1.0%)	1 (0.8%)	
Screws	9 (3.8%)	7 (6.8%)	5 (3.7%)	
Hemiarthroplasty	227 (95.4%)	95 (92.2%)	130 (95.5%)	

Continuous data are shown as mean (SD)

fract fracture, *n.s.* not significant

Table 2 Reasons of surgical delay

Medical reasons, *n* (%)	Organizational reasons, *n* (%)
Chronic chest condition, 68 (23.8%)	Unavailable operating room, 78 (23.0%)
Antiplatelet therapy reversal, 66 (23.1%)	Pending medical consultation, 68 (20.0%)
Cardiac arrhythmia, 42 (14.7%)	Admission on weekend or holidays, 64 (18.9%)
Acute chest infection, 26 (9.1%)	Unavailable operating room time, 41 (12.1%)
Electrolyte imbalance, 22 (7.7%)	Waiting cardiac test, 40 (11.8%)
Renal disease, 21 (7.3%)	Waiting laboratory results, 27 (7.9%)
Uncontrolled diabetes, 14 (4.9%)	Waiting family discussion, 21 (6.2%)
Cardiac ischemia, 8 (2.8%)	
Coagulopathy, 8 (2.8%)	
Other drugs, 6 (2.1%)	
Gastrointestinal bleeding, 5 (1.7%)	

operating room (23.0%), pending medical consultation (20.0%), and admission on weekend or holidays (18.9%).

In the non-delay group, 152 (24.9%) patients had no active major comorbidities, 287 (47.1%) had one to two comorbidities, and 170 (28.0%) at least three comorbidities. In the organizational reasons delay group, these rates were 74 (21.8%), 193 (57.0%), and 72 (21.2%), respectively, while in the medical reasons delay group were 0, 108 (37.7%), and 178 (62.3%), respectively. These differences were significant ($p = 0.001$). The most common comorbidities in any groups were hypertension (63%), heart disease (35%), diabetes (26%), and chronic obstructive pulmonary disease (19%).The haematological or serum biochemical parameters were similar between groups.

At least one post-operative complication or severe exacerbation of previous comorbidity (Table 3) occurred in 102 (16.7%) patients of the non-delay group, 56 (19.6%) in the medical reasons delay group, and 90 (26.5%) in the organizational reasons delay group, and these differences were significant ($p = 0.001$). There were no significant differences in complications (Table 4) between the non-delay group and medical reasons delay group, but there were significant differences in urinary tract infection, pulmonary exacerbation, and acute pneumonia rates between these groups and the organizational reasons delay group. In the multivariate analysis, significant risk factors for postoperative complication were age (OR, 1.3; 95% CI, 1.1–3.1; $p = 0.004$), male gender (OR, 1.1; 95% CI, 1.05–2.8; $p = 0.023$), chronic obstructive pulmonary

Table 3 Main post-operative complications

	No delay $n = 609$	Medical delay $n = 286$	Organizational delay $n = 339$	*p* value
Wound infection	11 (1.8%)	7 (2.4%)	5 (1.5%)	n.s.
Dementia	16 (2.6%)	7 (2.4%)	9 (2.6%)	n.s.
Urinary infection	16 (2.6%)	8 (2.8%)	19 (5.6%)	0.047
Pulmonary exacerbation	9 (1.5%)	9 (3.1%)	22 (6.5%)	0.004
Pneumonia	12 (2.0%)	4 (1.4%)	14 (4.1%)	0.039
Cardiac arrhythmia	13 (2.1%)	6 (2.1%)	8 (2.3%)	n.s.
Myocardial infarction	5 (0.8%)	2 (0.7%)	3 (0.9%)	n.s.
Renal insufficiency	8 (1.3%)	7 (2.4%)	8 (2.3%)	n.s.
Deep vein thrombosis	2 (0.3%)	3 (1.0%)	4 (1.2%)	n.s.
Thromboembolism	0	3 (1.0%)	4 (1.2%)	n.s.
Stroke	9 (1.5%)	3 (1.0%)	3 (0.9%)	n.s.
Gastrointestinal bleeding	1 (0.2%)	1 (0.3%)	0	n.s.
Complicated patients	102 (16.7%)	61 (21.3%)	95 (28.0%)	0.001
30-day mortality	9 (1.5%)	6 (2.0%)	9 (2.6%)	n.s.
6-month mortality	35 (5.7%)	19 (6.6%)	32 (9.4%)	n.s.
1-year mortality	64 (10.5%)	37 (12.9%)	65 (18.2%)	0.009

n.s. not significant

disease (OR, 1.6; 95% CI, 1.01–3.05; $p = 0.016$), and organizational delay reason (OR, 1.9; 95% CI, 1.3–4.25; $p = 0.002$).

Mortality rates related to variables of interest are shown in Table 4. The cumulative mortality rate at 30 days, six months, and one year after surgery are shown in Table 5. There were no significant differences between the non-delay group and medical reasons delay group, but there were significant differences in one year mortality between these groups and the organizational reasons delay group. The commonest causes of death were pneumonia (31.3%) and cardiac failure (22.4%). According to multiple logistic regression model, age (OR, 1.2; 95% CI, 1.03–2.2; $p = 0.003$) and organizational delay reason (OR, 2.3; 95% CI, 1.1–5.3; $p = 0.002$) had a significant impact on one year mortality.

Discussion

In the present study, there was a high rate of patients (50.7%) who received surgery delayed more than two days after admission. According to our criteria, the wait for surgery was due to medical reasons in 23.2% and to organizational reasons in 27.5%. There were no significant differences in complications or one year mortality between patients with surgery within two days after admission and those with delayed surgery for medical reasons. However, the patients with delayed surgery for organizational reasons had a significant higher rate of postoperative complications and one year mortality compared to the other two groups.

The influence of the timing of hip fracture surgery on mortality in elderly patients is still very controversial. Some authors have reported benefits of the early operation within two days on complications and mortality [2, 20], others did not find influence if the surgery was delayed more than two days [10, 11], and others do not find a negative effect if patients received surgery within four days after admission [3, 21]. On the other hand, other studies have reported that medical conditions, patient age, and gender were more important factors in influencing mortality compared to surgery delay [6]. Yonezawa et al. [22] reported that early surgery had a higher mortality rate in those patients who had a compromised health at the time of the injury.

Most available evidences are generally based on retrospective studies of small sizes. Most of them have compared only the likelihood of death among patients who underwent early surgery and those who received delayed surgery [3, 4, 21, 23]. However, these studies did not report the causes of delay. Thus, failure to differentiate patients with medically necessary and non-medical delays may lead to an underestimation of the benefit of early surgery. And conversely, failure to consider the role of the reasons of surgical delay may lead to conclusions based on a confounded association between timing of

Table 4 Mortality rates related to variables of interest

	3-month mortality ($n = 24$)	6-month mortality ($n = 63$)	12-month mortality ($n = 79$)	Total mortality ($n = 166$)	p (total)
Age					
< 75 year ($n = 411$)	6 (1.5%)	13 (3.1%)	18 (4.3%)	37 (9.0%)	
≥ 75 year ($n = 913$)	18 (2.0%)	50 (5.5%)	61 (6.7%)	129 (14.1%)	0.005
Gender					
Female ($n = 860$)	9 (1.0%)	39 (4.5%)	47 (5.5%)	96 (11.1%)	
Male ($n = 464$)	15 (3.2%)	24 (5.2%)	32 (6.9%)	71 (15.3%)	0.025
Fracture					
Trochanteric ($n = 757$)	13 (1.7%)	44 (5.8%)	47 (6.2%)	104 (13.7%)	
Cervical ($n = 567$)	11 (1.9%)	19 (3.3%)	32 (5.6%)	62 (10.9%)	n.s.
Surgery					
Osteosynthesis ($n = 782$)	13 (1.7%)	44 (5.6%)	48 (6.1%)	105 (13.4%)	
Hemiarthroplasty ($n = 542$)	11 (2.0%)	19 (3.5%)	31 (5.7%)	61 (11.2%)	n.s.
Comorbidity					
≤ 2 ($n = 814$)	15 (1.8%)	19 (2.3%)	51 (6.2%)	85 (10.4%)	
> 3 ($n = 420$)	9 (2.1%)	44 (10.5%)	28 (6.7%)	81 (19.2%)	0.001
Surgery delay					
≤ 2 days ($n = 609$)	9 (1.5%)	26 (4.2%)	29 (4.7%)	64 (10.5%)	
> 2 days ($n = 715$)	15 (2.1%)	37 (5.2%)	50 (7.0%)	102 (14.2%)	0.023

Percentages are related to the category

n.s. not significant

Table 5 Statistical differences in complication and mortality rates between groups

	Medical delay vs. non-delay *p* value	Organizational delay vs. non-delay *p* value	Medical delay vs. organizational delay *p* value
Wound infection	0.342	0.463	0.363
Dementia	0.537	0.459	0.870
Urinary infection	0.519	*0.017*	0.085
Pulmonary exacerbation	0.083	*0.001*	*0.039*
Pneumonia	0.381	*0.042*	*0.033*
Cardiac arrhythmia	0.601	0.493	0.523
Myocardial infarction	0.602	0.590	0.579
Renal insufficiency	0.169	0.174	0.572
Deep vein thrombosis	0.189	0.125	0.592
Thromboembolism	0.098	0.057	0.592
Stroke	0.432	0.325	0.574
Gastrointestinal bleeding	0.537	0.588	0.705
Complicated patients	0.060	*0.001*	0.033
30-day mortality	0.551	0.203	0.314
6-month mortality	0.535	*0.027*	0.054
1-year mortality	0.231	*0.002*	*0.042*

Values in italics indicate statistical significance

surgery and death, and this could lead to overestimating the risk of death associated with delayed surgery [22].

There is some consensus to perform the surgery as soon as possible, preferably within two days from admission [20]. However, the early surgery may not always be feasible. The current literature shows a wide variability in the timing to surgery used, with surgery delayed more than two days after admission ranging between 14–33% [3, 23] and 50–69% [4, 24]. In the present study, the rate of delayed surgery was high, for both medical and organizational reasons, in the lower limit of that described in the literature. In a recent study using also a co-managed care model, the time to surgery was more than two days in 40% of the patients [25].

Regarding the delay for medical reasons in the present study, 34% of the patients had three or more comorbidities at admission, and 42% of them had delayed surgery. ASA score and Charlson index were good predictors for surgery delay. The main conditions for delay were exacerbation of chronic pulmonary disease (24%), antiplatelet therapy reversal (23%), and uncontrolled cardiac arrhythmia (15%), which was in agreement with the literature [11, 22]. Li et al. [26] reported that 74% of the patients had any active comorbidity at admission and 47% had two or more comorbidities, which was considered an important reason for surgery delay. In systematic reviews, higher ASA grade and the presence of three or more comorbidities have been demonstrated to be significant indicators of one year mortality after hip fracture [27]. Regarding the delay due to coagulation problems, in our centre, the operation was almost systematically rejected by the anesthesiologist if the International Normalized Ratio (INR) was higher than 4 due to all patients receiving spinal anaesthesia. This was mainly referred to antiplatelets, isolated or combined, for which there were no antidotes, but operation was not delayed by aspirin or vitamin K antagonist therapies. In the literature, a substantial number of patients were also delayed because of antiplatelet therapy [24] due to some concerns about an increased risk of surgical bleeding and the development of spinal haematoma after spinal or epidural anaesthesia [28]. However, other recent studies reported that clopidogrel should not be a cause for delayed surgery [29] because an amount of blood transfusion and post-operative complications are not influenced by this therapy.

In the present study, delay was also frequently favoured by organizational factors. In the literature, the most frequent reasons were admission at weekend or holiday due to the reduction of hospital resources [10, 30], waiting for routine medical clearance or laboratory results [11], and unavailable operating room or surgeon [11, 31].

Regarding post-operative complications in the present study, the non-delay group had similar rate than the medical reasons delay group, but both groups had significantly lower rate than the organizational reasons delay group. In medically stable patients at admission, Orosz et al. [11] found that the likelihood of having major complications was significantly less when they were operated less than 24 hours. The medical reasons for surgical delay were undertaken to avoid major complications including death due to precipitous surgery in patients with active medical problems who need pre-operative optimization [7, 13]. Several authors have suggested that patients with medically necessary delays may be less likely to die with longer wait times than if they received early surgery [6, 11]. However, others [8] found that a delay of more than 24 hours was a significant predictor of a minor medical complication and a delay of more than 48 hours was also predictive of a major medical complication.

Regarding the mortality after hip fracture surgery, similar early and one year rates were found in the present study between the non-delay and medical reasons delay groups, but both groups had significantly lower rate than the organizational reasons delay group. Only one recent study [4] reported mortality due to medical and organizational reasons for surgery delay. The authors found also significantly higher mortality in the delays for organizational reasons compared to medical reasons. Like us, Grimes et al. [6] reported in-hospital mortality rate of 4% in the stable patients at active admission who had delayed surgery, and 7% in those with active medical problems who had delayed surgery, with no significant difference. In the present study, the mortality rate in patients with delayed surgery for medical reasons was in agreement with other studies [9, 23] and systematic reviews [1].

This study had certain advantages. First, its prospective design is based on a large cohort of consecutive patients that represents the daily experience from clinical practice. Detailed clinical data were collected on the admission, hospital course, and after discharge. However, the study has also several limitations. This observational study does not have the accuracy of a randomized controlled trial, but this latest design is not ethical because it would not be possible to delay surgery intentionally. Another potential limitation was that waiting for antiplatelet therapy (not including aspirin) was considered a medical reason, while other authors consider that this is not a cause for a delay. However, in our centre, that decision was ordered by the anesthetists and thus the patient was informed. The results may in part be attributable to specific characteristics out of hospital. Due to the variability between countries and centers for the patient management, those results might not be generalized to other cohorts of patients. The search for organizational patterns and clinical pathways at the level of each hospital is important. Further studies are required to evaluate different systems of medical care and establish an efficient protocol for the management of these patients.

In conclusion, this study suggests that waiting time for hip fracture surgery more than two days was not associated with higher complication or mortality rate if waiting was to stabilize patients with active comorbidities at admission, compared to stable patients with early surgery. However, the patients with delayed surgery for organizational reasons had a significant higher rate of postoperative complications and one year mortality compared to the other two groups. While it is desirable to perform an early surgery within two days for stable patients at admission, in patients with complex comorbidities, the surgery should be performed once they are optimized. Surgery delay because of organizational reasons or a lack of resources is a risk factor for complications and mortality.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was not required by the institutional review board because the study was considered department evaluation.

References

1. Hu F, Jiang C, Shen J, Tang P, Wang Y (2012) Preoperative predictors for mortality following hip fracture surgery: a systematic review and meta-analysis. Injury 43:676–685. https://doi.org/10.1016/j.injury.2011.05.017
2. Shiga T, Wajima Z, Ohe Y (2008) Is operative delay associated with increased mortality of hip fracture patients? Systematic review, meta-analysis, and meta-regression. Can J Anaesth 55:146–154. https://doi.org/10.1007/BF03016088
3. Anthony CA, Duchman KR, Bedard NA, Gholson JJ, Gao Y, Pugely AJ, Callaghan JJ (2017) Hip fractures: appropriate timing to operative intervention. J Arthroplast 32:3314–3318. https://doi.org/10.1016/j.arth.2017.07.023
4. Cha YH, Ha YC, Yoo JI, Min YS, Lee YK, Koo KH (2017) Effect of causes of surgical delay on early and late mortality in patients with proximal hip fracture. Arch Orthop Trauma Surg 137:625–630. https://doi.org/10.1007/s00402-017-2674-2
5. National Institute for Health and Care Excellence (2011). NICE clinical guideline 124. The management of hip fractures in adults. Modified March 2014. http://www.nice.org.uk/guidance/cg124
6. Grimes JP, Gregory PM, Noveck H, Butler MS, Carson JL (2002) The effects of time-to-surgery on mortality and morbidity in patients following hip fracture. Am J Med 112:702–709. https://doi.org/10.1016/S0002-9343(02)01119-1
7. Moran CG, Wenn RT, Sikand M, Taylor AM (2005) Early mortality after hip fracture: is delay before surgery important? J Bone Joint Surg Am 87:483–489. https://doi.org/10.2106/JBJS.D.01796
8. Lefaivre KA, Macadam SA, Davidson DJ, Gandhi R, Chan H, Broekhuyse HM (2009) Length of stay, mortality, morbidity and delay to surgery in hip fractures. J Bone Joint Surg (Br) 91:922–927. https://doi.org/10.1302/0301-620X.91B7.22446.
9. Lund CA, Møller AM, Wetterslev J, Lundstrøm LH (2014) Organizational factors and long-term mortality after hip fracture surgery: a cohort study of 6143 consecutive patients undergoing hip fracture surgery. PLoS One 9:e99308. https://doi.org/10.1371/journal.pone.0099308
10. Hagino T, Ochiai S, Senga S, Watanabe Y, Wako M, Ando T, Haro H (2015) Efficacy of early surgery and causes of surgical delay in patients with hip fracture. J Orthop 12:142–146. https://doi.org/10.1016/j.jor.2015.01.013

11. Orosz GM, Hannan EL, Magaziner J, Koval K, Gilbert M, Aufses A, Straus E, Vespe E, Siu AL (2002) Hip fracture in the older patient: reasons for delay in hospitalization and timing of surgical repair. J Am Geriatr Soc 50:1336–1340. https://doi.org/10.1046/j.1532-5415.2002.50353.x
12. Sheehan KJ, Sobolev B, Villán Villán YF, Guy P (2017) Patient and system factors of time to surgery after hip fracture: a scoping review. BMJ Open 7:e016939. https://doi.org/10.1136/bmjopen-2017-016939
13. Switzer JA, Bennett RE, Wright DM, Vang S, Anderson CP, Vlasak AJ, Gammon SR (2013) Surgical time of day does not affect outcome following hip fracture fixation. Geriatr Orthop Surg Rehabil 4:109–116. https://doi.org/10.1177/2151458513518344
14. Lizaur-Utrilla A, Calduch Broseta JV, Miralles Muñoz FAS, Segarra Soria M, Diaz Castellano M, Andreu Gimenez L (2014) Eficacia de la asistencia compartida entre cirujanos e internistas para ancianos con fractura de cadera. Med Clin 143:386–391. https://doi.org/10.1016/j.medcli.2013.07.033
15. American Society of Anesthesiologists (2008) Relative value guide. Online http://www.asahq.org
16. Charlson M, Szatrowski TP, Peterson J, Gold J (1994) Validation of a combined comorbidity index. J Clin Epidemiol 47:1245–1251. https://doi.org/10.1016/0895-4356(94)90129-5
17. Hodkinson HM (1972) Evaluation of a mental test score for assessment of mental impairment in the elderly. Age Ageing 4:233–238. https://doi.org/10.1093/ageing/1.4.233
18. Katz S, Ford A, Moskowitz R, Jackson B, Jaffe M (1963) Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychological function. JAMA 185:914–919. https://doi.org/10.1001/jama.1963.03060120024016.
19. Ware JE Jr, Kosinski M, Keller SD (1996) A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care 34:220–233. https://doi.org/10.1097/00005650-199603000-00003
20. Simunovic N, Devereaux PJ, Sprague S, Guyatt GH, Schemitsch E, Debeer J, Bhandari M (2010) Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. CMAJ 182:1609–1616. https://doi.org/10.1503/cmaj.092220
21. Rodriguez-Fernandez P, Adarraga-Cansino D, Carpintero P (2011) Effects of delayed hip fracture surgery on mortality and morbidity in elderly patients. Clin Orthop Relat Res 469:3218–3221. https://doi.org/10.1007/s11999-010-1756-z
22. Yonezawa T, Yamazaki K, Atsumi T, Obara S (2009) Influence of the timing of surgery on mortality and activity of hip fracture in elderly patients. J Orthop Sci 14:566–573. https://doi.org/10.1007/s00776-009-1380-5
23. Bohm E, Loucks L, Wittmeier K, Lix LM, Oppenheimer L (2015) Reduced time to surgery improves mortality and length of stay following hip fracture: results from an intervention study in a Canadian health authority. Can J Surg 58:257–263. https://doi.org/10.1503/cjs.017714
24. Fantini MP, Fabbri G, Laus M, Carretta E, Mimmi S, Franchino G, Favero L, Rucci P (2011) Determinants of surgical delay for hip fracture. Surgeon 9:130–134. https://doi.org/10.1016/j.surge.2010.11.031
25. Forni S, Pieralli F, Sergi A, Lorini C, Bonaccorsi G, Vannucci A (2016) Mortality after hip fracture in the elderly: the role of a multidisciplinary approach and time to surgery in a retrospective observational study on 23,973 patients. Arch Gerontol Geriatr 66:13–17. https://doi.org/10.1016/j.archger.2016.04.014
26. Li Y, Lin J, Wang P, Yao X, Yu H, Zhuang H, Zhang L, Zeng Y (2014) Effect of time factors on the mortality in brittle hip fracture. J Orthop Surg Res 9:37. https://doi.org/10.1186/1749-799X-9-37
27. Smith T, Pelpola K, Ball M, Ong A, Myint PK (2014) Pre-operative indicators for mortality following hip fracture surgery: a systematic review and meta-analysis. Age Ageing 43:464–471. https://doi.org/10.1093/ageing/afu065
28. Chassot PG, Delabays A, Spahn DR (2007) Perioperative antiplatelet therapy: the case for continuing therapy in patients at risk of myocardial infarction. Br J Anaesth 99:316–328. https://doi.org/10.1093/bja/aem209
29. Pailleret C, Ait Hamou Z, Rosencher N, Samama CM, Eyraud V, Chilot F, Baillard C (2017) A retrospective comparison between delayed and early hip fracture surgery in patients taking clopidogrel: same total bleeding but different timing of blood transfusion. Int Orthop. https://doi.org/10.1007/s00264-017-3571-6
30. Ricci WM, Brandt A, McAndrew C, Gardner MJ (2015) Factors affecting delay to surgery and length of stay for patients with hip fracture. J Orthop Trauma 29:109–114. https://doi.org/10.1097/BOT.0000000000000221
31. Vidán MT, Sánchez E, Gracia Y, Marañón E, Vaquero J, Serra JA (2011) Causes and effects of surgical delay in patients with hip fracture: a cohort study. Ann Intern Med 155:226–233. https://doi.org/10.7326/0003-4819-155-4-201108160-00006