The influence of the patient's health-state compared with time to surgery on the outcomes following hip fracture surgery: a longitudinal study of 4,791 patients

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ABSTRACT

Introduction: This study investigated whether the health-state of hip fracture patients or the time to surgery had a greater effect on outcomes.

Methods: Of the 5,120 patients admitted with a fragility hip fracture, 4,791 (93.6%) were included in the analysis. Patients operated after 36 hours were initially group by length of delay (36–48 hours and >48 hours) and then regrouped by delay cause (medical and administrative). Patients operated within 36 hours were the comparative group. Data were collected at admission, discharge, 120 days and 365 days post discharge.

Results: Multivariate logistic regression analysis revealed that the patients who were delayed over 36 hours, owing to medical causes, had a higher mortality at all studied time points, but the patients who were delayed owing to administrative causes had no increase in mortality. Analysis by time to surgery revealed that patients operated after 36 and 48 hours had a higher mortality at discharge only. Medically delayed patients were less likely to return to their premorbid level of residence at discharge. Older, male patients had a higher risk of inferior outcomes. Postoperative length of stay was significantly greater in the >48-hour delay group and the medical delay group. All delay groups had a significantly higher rate of reoperation within 30 days compared with the no-delay group.

Conclusions: The health-state of the hip fracture patient had a greater impact on the outcome in contrast to time to surgery. This study concurs that hip fracture patients should

receive surgery within the timeframe of current guidelines, but medically unwell patients have relatively worse outcomes and should receive enhanced clinical attention.

Introduction

Elderly patients frequently sustain hip fractures and the injury carries a significant mortality risk.(1) There is also a significant morbidity risk that renders many patients unable to return to their premorbid level of mobility and, potentially, less than two thirds of patients are able to return to their premorbid level of residence.(1) Many factors, such as comorbidity, non-independent living and dementia have been identified as contributing to the high mortality and morbidity associated with hip fractures.(2) Moreover, the time to surgery has also been identified as a risk factor for poor outcomes.(3–8)

A preoperative delay of over 48 hours (h) has been found by four metanalyses to be associated with an increased risk of mortality(4–7) and many countries use the 48-hour time-point as an acceptable limit. (9) However, there is ongoing debate over the acceptable length of preoperative delay(8) and it has been recommended that immediate surgery be delayed if preoperative medical optimisation is required.(10, 11) Hospitals in the United Kingdom have been set a Government target of 36 hours,(12) which was reinforced by the guidelines from the National Institute for Health and Care Excellence (NICE).(11)

Some studies published on the impact of surgical timing on patient outcomes have looked specifically at the 36-hour time point but have been limited by a short follow-up, low cohort size, examined the effect of risk factors on surgical delay or not compared medically well with unwell patients.(3, 10, 13–16) The aim of this paper was to investigate whether the timing of surgery or the cause for the delay (medical or administrative) had a greater impact on outcomes for hip fracture patients from discharge to 12 months postoperative.

Methods

Patients and outcome measures

5120 hip fractures were admitted to a large National Health Service Foundation Trust between July 2011 and December 2016. Once exclusion criteria were applied (no operation, age under 60 years, pathological fracture, non-operative management, an incomplete preliminary data-set and unknown reason for the delay to surgery) (Figure 1) the dataset consisted of 4791 cases. Time to surgery was calculated from the time of admission to the Emergency Department to the time of surgery. The patients operated within 36h were the 'no delay' group. The patients who experienced a preoperative delay >36h were grouped initially by length of preoperative delay – 36-48h and >48h. The same cohort of delayed patients were separately grouped by the cause for the delay – medical or administrative. Patients were included in the 'medical delay' group if they required either medical optimisation to maximise their surgical safety or further investigations, such as an unconfirmed neck of femur fracture. Reasons for 'administrative delay' were in accordance with the National Hip Fracture Database (NHFD) criteria - awaiting space on theatre list, problem with staff cover for the operation, awaiting inpatient or high dependency bed, problem with theatre/equipment, cancelled due to list over-run.(1) The primary outcome measures for this study were mortality and return to premorbid level of residence or mobility The secondary outcome measures were length of stay, incidence of reoperation within 30 days (d) postoperative and the incidence of venous thromboembolism during admission and within 30d of discharge.

Data collection

Data were collected at four time points: admission to the operating hospital, discharge from the operating hospital, 120d postoperative and 365d postoperative. Return to premorbid level of mobility was not evaluated at the time of discharge. All data were collected temporaneously and telephone interviews were performed to gather data postdischarge. The residence and mobility status of patients was captured using the established stratification of the NHFD.(1)

Statistical analysis

Analyses were conducted using binary logistic regression with the response variables of mortality (deceased versus alive); change in premorbid level of residence ("improved or no change" versus "more dependent"); change in premorbid level of mobility ("improved or no change" versus "reduction in mobility"). Analysis of the changes in residence and mobility status was only performed on the living patients at each time-point. These primary outcome variables were then examined for the effects of "time to surgery" (<36h, 36-47.9h, >48h); "reason for delay >36h" (medical, administrative); "gender" and "age". Logistic regression analyses were run with each covariate individually and then only the covariates that were statistically significant were included in a multivariate analysis with a comparison made with the no delay (<36h) group. Data analysis was carried out in IBM SPSS Statistics version 22 and Graphpad Prism version 9.2 (GraphPad Software Inc., San Diego, U.S.A.). Significant findings were found in the regression analyses when the 95% Confidence Interval for Odds Ratio did not traverse zero. Continuous variables were analysed using the one-way Analysis of Variance (ANOVA) or Kruskal-Wallis tests and categorical variables were analysed using the chi-square test. Significance in these tests was determined when $p \leq 0.05$.

Results

Descriptive statistics of the groups

The total number of patients included in the data analysis was 4791. The mean age of the patients was 84.18 years (range 60-106) and 72.5% were female. For the whole patient cohort the mean time to surgery 33.75h. Table 1 details patient characteristics of each group and reveals that there was a significant difference in the proportion of female patients, age, ASA (American Society of Anesthesiologists) grade, intracapsular fractures, total hip replacements (THR) and the premorbid proportion of patients who were freely mobile without walking aids. The shortest time to operation in the no delay group was 1.02h and the longest time to operation in the >48h delay group was 191.58h, a patient who needed prolonged medical optimisation on arrival to hospital.

Primary outcome measures

Initial analysis of the whole patient cohort revealed that at 365d postoperative 26.0% of patients had died. Of the living patients, 95.4% had returned to their premorbid level of residence and 82.1% had returned to their premorbid level of mobility. Statistically significant results from the multivariable logistic regression analysis showed that patients had a higher mortality at the time of discharge if they were in the 36-48h delay and >48h delay groups (Table 2). Patients who were delayed >36h for medical optimisation had a higher mortality at the time of discharge, 120d postoperative and 365d postoperative. Patients who were delayed for administrative reasons experienced no significant increase in mortality at any studied time-point. Increasing age and male sex were independent predictors of higher mortality at all three time points.

Time to surgery had no significant effect on the ability of patients to return to their pre-morbid level of residence but patients delayed for medical optimisation were less likely to return to their pre-morbid level of residence at all time-points but only the discharge time-point was statistically significant (Table 2). Patients delayed for an administrative delay were significantly more likely to return to their pre-morbid level of residence than the patients who had no delay at the discharge time-point and at 365 days postoperative.

Increasing age and male sex were independent predictors of patients not returning to their premorbid level of residence at the discharge time-point and at 365 days postoperative.

An >48h delay increased the chance of patients not returning to their pre-morbid level of mobility at 365d postoperative and increasing age was an independent predictor of patients not returning to their premorbid level of mobility at 120d and 365d postoperative (Table 2). Data on the return to premorbid mobility was not captured at the discharge time-point.

Secondary outcome measures

The postoperative length of stay was found to be significantly higher in the patients delayed >48h (p=<0.0001) and delayed for medical reasons (p=<0.0001) (Table 3). Excluding the medical delay patients from the 36-48h and >48h delay groups showed that the length of stay in the >48h delay group reduced by almost one day but was still was significantly longer than the no delay group (p=0.023).

There was a significant increase in the number of reoperations for all patients delayed >36h (Table 3). The most frequent reason for reoperation in all three groups was a periprosthetic fracture. Other reasons included reduction of dislocated prosthesis, washout, excision arthroplasty, revision of internal fixation and conversion to total hip replacement. No significant difference between the groups was found in the rates of venous thromboembolism during admission or within 30d of discharge (Table 3).

Administrative delay causes

Subgroup analysis of the patients who were delayed beyond 36h for administrative causes revealed that the primary reason was due to a lack of space on the theatre list (Table 4). The proportion of delays due to a lack of theatre space was significantly greater in the 36-48h delay group compared to the >48h delay group (p=0.0003). The second main reason for an administrative delay was due to a lack of theatre, surgical or anaesthetic staff cover and the proportion of delays due to a lack of staff cover in the >48h delay group was significantly greater than the 36-48h group (p=0.0006). Additional infrequent and non-statistically significant administrative reasons for delays are included in Table 4. Patients requiring a THR experienced a prolonged administrative delay (Table 1), but their primary and secondary outcomes were not negatively affected.

Discussion

Four meta-analyses identified that a delay of >48h prior to hip fracture surgery is detrimental to patient outcomes.(4–7) Importantly however, the authors have acknowledged that their findings were weakened by included studies not accounting for delayed patients requiring medical optimisation prior to surgery. It has been suggested that the medically unwell patients act as a confounding factor for worse outcomes.(7, 17) In the present study, an increased mortality rate was found in patients who were delayed due to prolonged preoperative medical optimisation at all studied time-points. Conversely, no increase in mortality rate was found in the patients who were delayed for administrative causes. When the patients were grouped by a time to surgery beyond 36h and 48h, an increased risk of mortality was found at the discharge time-point only. Previous studies that excluded patients who were delayed for medical reasons found that the health-state of the patient on arrival at the hospital had a significantly greater influence on the mortality rate compared to the length of preoperative surgical delay.(16, 18–20) Furthermore, studies have found that a high ASA grade was associated with higher mortality and not preoperative delay.(16, 21, 22) This is the first study that has analysed the delayed patient cohort based separately by time to surgery and cause of delay and confirms that the health-state of the patient on arrival to the hospital has a greater effect on mortality than the length of the preoperative surgical delay.

The ability of elderly patients to return to their premorbid level of residence and mobility after hip fracture surgery has not been well studied with conflicting findings published in the literature. Some authors have found that prolonged preoperative delay had a detrimental effect on the ability of patients to return to independent living.(3) However, other authors have found no effect on functional recovery, even after a preoperative delay of seven days.(23) The present study suggested that the patients delayed for medical reasons were less likely to return to their premorbid level of residence. However overall, no consistent effect was found on the ability to patients to return to their premorbid level of residence or mobility based on either the timing of surgery or the cause for delay and reflects the lack of coherence in the literature regarding functional recovery. Increasing age and male sex was found to have a negative impact on mortality and functional outcome and majority of studied time-points, which is consistent with the literature.(23)

In this study, the postoperative length of stay was found to be significantly increased in the patients delayed >48h and for medical reasons. The length of stay was still significantly raised in the >48h delay group when the medical delay patients were excluded from the analysis, showing that a delay of >48h was an independent risk factor for a longer postoperative recovery and will negatively affect a hospital's health economics. These finding are consistent with previous reports.(23–25) It is not clear why the patients delayed beyond 36h in this study had a significantly increased risk of a reoperation within 30 days compared to the patients who experienced less than a 36h delay. As a delay was not found to affect the ability of a patient to return to their pre-operative level of mobility, further study of patient's biochemical and cognitive parameters may suggest an explanation.

The importance of a medical input from experienced orthogeriatricans has been identified previously with several papers, including a systematic review and meta-analysis, reporting reduced mortality, improved outcomes and reduced length of stay for patients with hip fractures.(26–29) Prompt review (within 72h) by an orthogeriatrician is part of the NICE guidance and also is a parameter of the best practise tariff. (11, 12) On average in 2020, 87% of hip fracture patients in England and Wales were assessed within this time frame, however, several trusts report rates as low as 20-30%.(1) Although an association between the specific medial cause for delay and mortality may not be identifiable,(10) the treatment of patients with hip fractures is multidisciplinary and expanding the availability of orthogeriatricians is likely to play a key-role in improving outcomes for hip fracture patients within the National Health Service health-care system.

Significantly more patients were delayed >36h and >48h when they required a hip hemiarthroplasty or, especially, a total hip replacement. This significant difference was primarily due to a lack of theatre, anaesthetic or surgical staff. Although further analysis into the relative proportions of the three different staff groups was not possible; we hypothesis that a lack of surgical staff was the principal cause of the delay. The lack of surgical staff availability is likely to be related to a hospital deficiency in surgeons who are willing to perform THR surgery for trauma. Low-volume hip surgeons should not undertake THR operations due to higher complication rates.(30) Furthermore, in comparison to a sliding hip screw operation, an arthroplasty operation requires an assistant, which increases staff demand. Although the administrative delays led to a significantly longer preoperative delay for the THR patients, their postoperative length of stay and outcomes were not significantly different to the no delay group, suggesting that the priority for these patients is specialist hip surgeon availability and not preoperative timing.

Although this was a longitudinal study that analysed 4791 patients, we acknowledge that the data was from a single centre and may not be nationally representative. However, the cohort of patients was comparable to the published literature.(4, 10, 16) Although our preliminary examination of the ASA grade data suggested that higher ASA grades had a strong associated with worse outcomes, missing data points (9-20% across the cohort groups) precluded reliable analysis and therefore the ASA grade data was only included in the descriptive statistics and not included in the multivariate calculation. Additionally, the data analysis in this paper would have been enhanced if the specific medical cause for the preoperative delay or Nottingham hip fracture scores had been recorded to provide a greater understanding of the medical delay patient cohort.

Conclusion

Time to surgery is a major potential modifiable risk factor for patient outcomes and this study builds on previously published literature to support hip fracture surgery within 48h and some data to support a 36h target. However, this study provides evidence that health-state of hip fracture patients on their arrival at hospital has a greater negative effect on mortality and return to residence than time to surgery. Enhanced clinical attention for medically unwell patients is likely to improve their outcomes but additional clarification on the relative impact of preoperative delay and patient health state is required. Moreover, the body of hip fracture evidence would benefit from future studies that separate out the medically well from the unwell to remove the inherent bias that is present when these two patient cohorts are combined.

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Figures

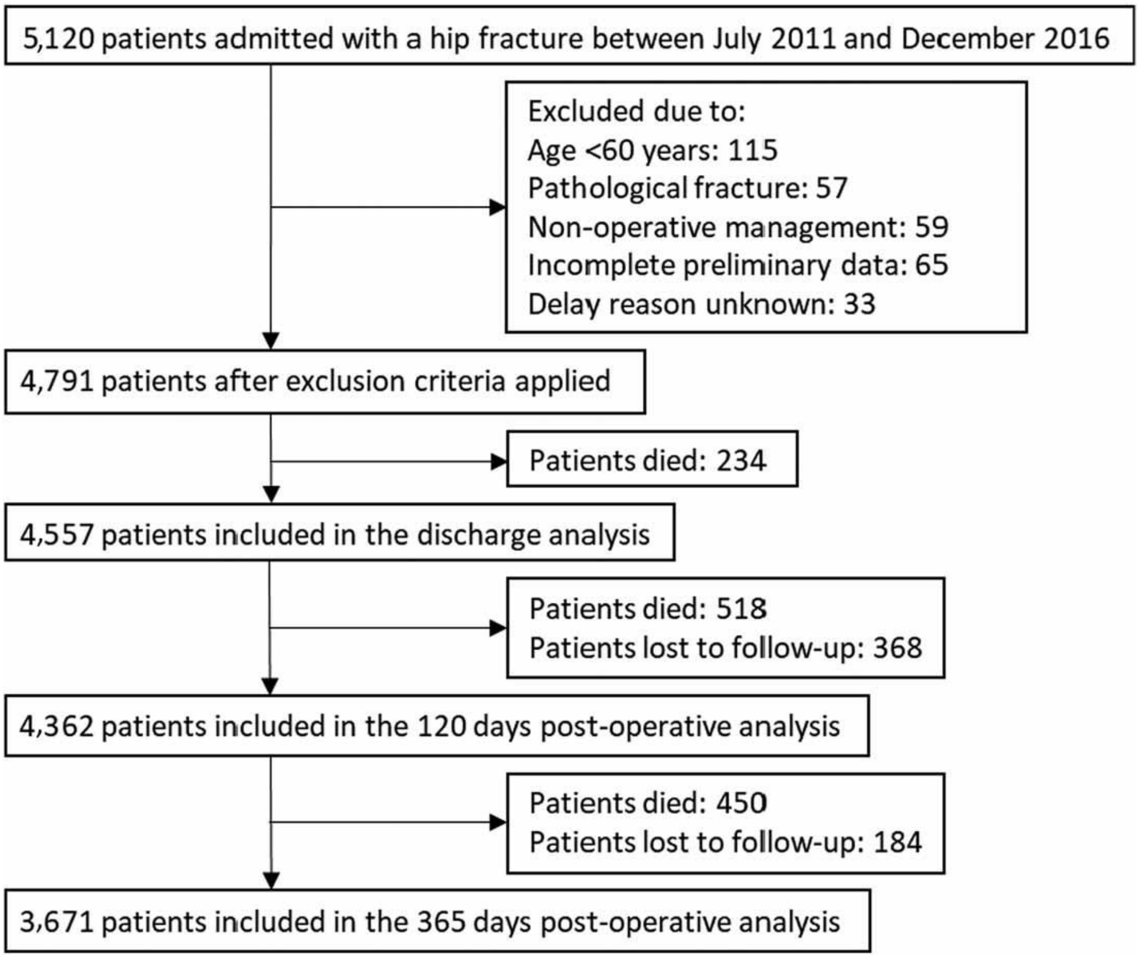

Figure 1: A flow chart demonstrating the exclusion criteria and patient stratification.

Tables

Table 1: Mean patient characteristics grouped by the time in hours from hospital admission to surgery. The patients delayed over 36 hours were also grouped by the cause of the delay (medical or administrative (admin). % – proportion of patients for each group. h – hours, SD – standard deviation, ASA – American Society of Anesthesiologists grade

Variable	No delay (<36h)	36-48h delay	>48h delay	Medical delay	Admin delay	Total	p-value
Time to surgery (h) (SD)	21.51 (7.0)	42.23 (3.2)	79.46 (28.5)	70.98 (33.3)	56.72 (22.6)	33.75 (24.9)	<0.0001
Number of patients (%)	3348 (69.9)	671 (14.0)	772 (16.1)	549 (11.4)	894 (18.7)	4791 (100)	<0.0001
Female (%)	2465 (73.6)	475 (70.8)	534 (69.1)	348 (63.4)	662 (74.0)	3475 (72.5)	<0.0001
Age (years) (SD)	84.40 (8.1)	84.03 (7.8)	83.38 (8.3)	83.77 (7.7)	83.64 (8.3)	84.18 (8.1)	0.0060
ASA grade (SD)	2.66 (0.7)	2.71 (0.7)	2.79 (0.7)	3.00 (0.7)	2.60 (0.7)	2.68 (0.7)	<0.0001
Intracapsular fracture (%)	1943 (58.0)	419 (62.4)	490 (63.5)	341 (62.1)	570 (63.8)	2852 (59.5)	0.0020
Total hip replacement (%)	61 (1.8)	19 (2.8)	65 (8.4)	11 (2.0)	73 (8.2)	145 (3.0)	<0.0001
Freely mobile without aids (%)	1032 (39.9)	232 (40.7)	272 (40.7)	173 (31.5)	360 (40.3)	1922 (40.1)	0.0035
Own home/sheltered accommodation (%)	2558 (76.4)	501 (74.7)	612 (79.3)	433 (78.9)	680 (76.1)	3671 (76.6)	0.18

Table 2: Results from multivariate analysis predicting mortality and failure to return to premorbid residence and level of mobility at the time of discharge, 120d postoperative and 365d postoperative. The data is presented as Odds Ratio and 95% Confidence Intervals and compared to the <36h delay group.

Mortality	**36-48h delay**	**>48h delay**	**Medical delay**	**Admin delay**	**Increasing age**	**Male sex**
Discharge	**1.57 (1.10-2.26)**	**1.97 (1.43-2.73)**	**2.13 (1.36-3.35)**	1.34 (0.91-1.99)	**1.06 (1.04-1.09)**	**1.37 (1.04-1.81)**
120 days	0.92 (0.68-1.24)	1.12 (0.85-1.47)	**1.57 (1.17-2.09)**	0.76 (0.57-1.02)	**1.06 (1.05-1.08)**	**1.64 (1.33-2.02)**
365 days	1.03 (0.77-1.37)	1.15 (0.88-1.51)	**1.79 (1.33-2.39)**	0.82 (0.62-1.09)	**1.07 (1.05-1.08)**	**1.80 (1.46-2.21)**
Residence						
Discharge	0.93 (0.78-1.11)	1.05 (0.89-1.24)	**1.47 (1.20-1.81)**	**0.83 (0.69-0.99)**	**1.04 (1.03-1.05**	**1.25 (1.08-1.43)**
120 days	1.01 (0.61-1.68)	0.95 (0.58-1.56)	1.32 (0.79-2.21)	0.80 (0.49-1.29)	1.01 (0.99-1.04)	1.34 (0.93-1.96)
365 days	0.80 (0.46-1.36)	0.76 (0.45-1.28)	1.34 (0.80-2.24)	**0.51 (0.29-0.88)**	**1.05 (1.02-1.07)**	**1.03 (0.68-1.54)**
Mobility						
120 days	1.07 (0.81-1.42)	1.20 (0.92-1.55)	1.27 (0.94-1.72)	1.06 (0.83-1.35)	**1.05 (1.04-1.07)**	0.87 (0.69-1.08)
365 days	0.91 (0.67-1.23)	**1.52 (1.06-2.20)**	1.12 (0.75-1.70)	0.85 (0.61-1.17)	**1.04 (1.02-1.05)**	0.90 (0.71-1.14)

Table 3: Secondary outcome results grouped into patients based on time to surgery and if the delay had a medical or an administrative (admin) cause. Postoperative length of stay (LOS) presented as median and interquartile range (IQR). Venous thromboembolism (VTE) diagnosed during admission or within 30 days of discharge. pts – number of patients, * - p<0.05, *** - p<0.001, **** - p<0.0001.

Outcome	No delay (<36h)	36-48h delay	>48h delay	Medical delay	Admin delay
Postoperative LOS (days) (IQR)	8.13 (5.40-13.13)	8.23 (5.34-13.28)	**10.03**** (6.32-17.31)**	**10.34**** (7.00-18.85)**	8.25 (5.80-13.76)
Postoperative LOS with medical delay patients excluded (days) (IQR)	8.13 (5.40-13.13)	8.13 (5.17-13.07)	**9.06* (6.13-14.81)**		
Reoperation <30 days (pts) (%)	58 (1.73)	**22 (3.23)***	**30 (3.89)*****	**17 (3.10)***	**35 (3.92)******
VTE (pts) (%)	21 (0.63)	4 (0.59)	7 (0.91)	6 (1.09)	5 (0.56)

Table 4: A table of the causes for a preoperative administrative delay. *** - p<0.001.

Administrative delay cause	36-48h delay number of patients (%)	>48h delay number of patients (%)
Awaiting space on theatre list	**441 (90.93) *** **	339 (83.29)
Problem with staff cover for the operation	29 (5.98)	**53 (13.02) *** **
Awaiting inpatient or high dependency bed	0 (0.0)	8 (1.97)
Problem with the theatre/equipment	7 (1.44)	5 (1.23)
Cancellation due to list over-run	6 (1.24)	2 (0.49)