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The risk of cardiorespiratory deaths persists beyond 30 days after proximal femoral fracture surgery

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ABSTRACT

Introduction: 30-day mortality is routinely used to assess proximal femoral fracture care, though patients might remain at risk for poor outcome for longer. This work has examined the survivorship out to one year of a consecutive series of patients admitted for proximal femoral fracture to a single institution. We wished to quantify the temporal impact of fracture upon mortality, and also the influence of patient age, gender, surgical delay and length of stay on mortality from both cardiorespiratory and non-cardiorespiratory causes.

Patients and methods: Data were analysed for 561 consecutive patients with 565 fragility type proximal femoral fractures treated surgically at our trauma unit. Dates and causes of death were obtained from death certificates and also linked to data from the Office of National Statistics. Mortality rates and causes were collated for two time periods: day 0–30, and day 31–365.

Results: Cumulative incidence analysis showed that mortality due to cardiorespiratory causes (pneumonia, myocardial infarction, cardiac failure) rose steeply to around 100 days after surgery and then flattened reaching approximately 12% by 1 year. Mortality from non-cardiorespiratory causes (kidney failure, stroke, sepsis etc.) was more progressive, but with a rate half of that of cardiorespiratory causes. Progressive modelling of mortality risks revealed that cardiorespiratory deaths were associated with advancing age and male gender ($p < 0.001$ for both), but the effect of age declined after 100 days. Non-cardiorespiratory deaths were not time-dependent.

Conclusion: We believe this analysis extends our understanding of the temporal impact of proximal femoral fracture and its surgical management upon outcome beyond the previously accepted standard (30 days) and supports the use of a new, more relevant timescale for this high risk group of patients. It also highlights the need for planning and continuing physiotherapy, respiratory exercises and other chest-protective measures from 31 to 100 days.

Introduction

Despite widespread implementation of national guidelines [1,2], improvements in care pathways and advances in surgical techniques, mortality after proximal femoral fractures remains high with rates of between 20% and 30% frequently quoted out to the first post operative year [3]. It is acknowledged that the majority of such deaths occur in the early post-operative period [4,5], with the National Hip Fracture Database reporting a 30-day mortality rate of just over 8% [6,7]. The arbitrary timeline of 30 days after surgery is commonly cited in many clinical and health related outcome publications as a surrogate quality indicator for proximal femoral care provision [8–10]. However, there is little corroborative evidence to validate this particular time period or to reflect upon the temporal impact of this injury.

Key non-modifiable factors are known to increase the risk of excessive mortality following proximal femoral fractures. These include age, male sex and anatomical position of the fracture, with a variable reported time period for increased mortality risk [11–14]. Modifiable risk factors, such as chest infection and anaemia, might intuitively be expected to have a greater impact perioperatively because of the stress imposed by the fracture and its surgical treatment. However with time, such influences will lessen and the outcome should ultimately not be influenced by the inpatient

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episode. Accurate delineation of the duration of impact of trauma from injury and the following surgical procedure will allow the clinician to: (1) assess more accurately and reliably the impact of early intervention measures upon outcome and (2) separate the effects of intervention from the influence of high level of comorbidities associated with the natural history of these fractures.

This work has examined the survivorship out to one year of a consecutive series of patients admitted for proximal femoral fracture to a single institution. We aimed to quantify the temporal impact of the fracture upon mortality after surgery and in the context of mortality due to unrelated causes. We hypothesised that mortality after proximal femoral surgery was dependent on patient age, gender, surgical delay and length of stay. We tested a further hypothesis that mortality from cardiorespiratory causes would be higher perioperatively and that it would be dependent on patient age, time to surgery and length of stay.

Patients and methods

After approval from the hospital's research ethics board, a retrospective chart review was conducted on consecutive patient episodes with fragility-type proximal femoral fractures admitted from the emergency department of a tertiary referral teaching hospital over a 24-month period (December 2008–December 2010) and treated surgically at its trauma unit. All patients with non-fragility type (pathological) fractures ($n = 10$) were transferred to an off-site elective unit for definitive treatment and were excluded from this study, as were patients treated non-operatively ($n = 19$). The day-to-day medical management of all patients was supervised by orthogeriatricians. Cardiology and respiratory consultations were sought for patients when requested by the orthogeriatricians or anaesthetists. Uniform blood transfusion and antibiotic policies were in place at the hospital during the study period. Data on patient demographics, dates and times of presentation to the emergency department, and admission to and discharge from the trauma ward and the hospital were obtained from the hospital's patient management system. Times to surgery (non-normally distributed) and lengths of hospital stay (normally distributed) were calculated for all patient episodes [15].

Dates of in-hospital deaths were obtained from the inpatient management system. Immediate and/or underlying causes of death were identified from the registers containing the medical certificates of cause of death (MCCD) in the hospital. Data on dates and causes of out-of-hospital deaths were obtained from the records of their respective registered family physicians' practices. For any remaining unaccounted deaths, the patient identifiers were linked to the 'mortality file' generated by the Office of National Statistics [ONS; Cardiff, UK]. This file contains data extracted from actual MCCDs filled in by general practitioners. All mortalities and respective causation were collated for all patients to a censoring point of one year after surgery. The recorded causes of death were referenced against the ICD-10 compendium to ensure each type contains system-specific diagnoses only. To facilitate analysis, the documented causes of death were grouped as follows:

1. Respiratory causes: 'Pneumonia', 'Respiratory failure', 'COPD'.
2. Cardiac causes: 'Myocardial infarction', 'Cardiac failure', 'Ischaemic heart disease'.
3. Renal causes: 'Acute kidney failure', 'Chronic kidney disease'.
4. Stroke: 'Stroke', 'Cerebrovascular disease'.
5. Acute abdominal events: 'Visceral perforation', 'Intestinal haemorrhage', 'Intestinal ischaemia'.
6. Sepsis: 'Multiorgan failure from sepsis/urinary infection'.
7. Dementia.
8. Frailty of old age.
9. Malignancy: 'Neoplasm'.

Statistical methods

Mortality rates and causes were collated for two time periods: period 1 (from surgery to 30 days) and period 2 (from 31 to 365 days after surgery). In the first instance these were tabulated and numbers of deaths due to different causes were compared simplistically using Fisher's exact test. For some causes there were few cases so causes of death were regrouped into two major categories: group 1 (cardiorespiratory) and group 2 (non-cardiorespiratory). We used cumulative incidence analysis to illustrate mortality due to the two groups of causes. A progressive modelling strategy was then produced to investigate risks for mortality from the different causes. The cause-specific mortality of the two groups was examined so as to identify risk factors for mortality assuming that risks for mortality were independent for the two groups. We then relaxed the assumption of independence of risk and used competing risks regression to investigate risk factors for death after surgery assuming that the risk factors impacted on more than one cause, using competing risks regression. We assessed the extent to which the effects of the individual variables impacted on combined cardiac and respiratory mortality were proportional i.e. did not change. This was estimated through a regression analysis of the residuals of the model against time, in a manner analogous to the residual analysis of Therneau and Grambsch used to analyse time dependency in Cox proportional hazards models [16].

Results

Five hundred and sixty one patients (137 males, 424 females) were admitted and treated surgically for 565 fractures (254 extracapsular, 311 intracapsular). Five patients suffered fractures on both sides but separated in time, i.e. there were no admissions with simultaneous bilateral fractures. The unit of analysis is therefore the patient episode, instead of the patient. The mean age was 80.6 years (median 82; range 65–100 years). The median and mode ASA grade was 3 (with 63% of the sample at the modal value). The median surgical delay for the cohort was 22 h 35 min (range: 3 h 10 min–434 h 26 min). The mean (SD) post-operative length of stay on the trauma ward was 17 days (16.3) while the total post-operative stay in hospital averaged 30 days (30.3).

The cumulative 30-day mortality was 5.3% ($n = 30$), which increased to 19.2% ($n = 78$) at one year. When grouped by fracture type (extracapsular v/s intracapsular), the mortality rates were similar at 30 days (5.46% v/s 5.49%, $p = 1$) but more of the intracapsular fracture patients had died in period 2 (10.8% v/s 21.1%, $p = 0.03$). One hundred and three episodes (18.2%) were associated with a delay to surgery of more than 36 h, 50 of these were for various medical reasons. Mortality rates for periods 1 and 2 were not significantly different between episodes with and without delays to surgery ($p = 0.3$ and $p = 1$, respectively).

Fig. 1 illustrates the causes of death for the two time periods. Cardiorespiratory causes accounted for the majority of deaths in both periods (70% and 57.6%, respectively). Pneumonia contributed directly to 40% of deaths in both periods. There were more deaths due to dementia, malignancy and frailty over period 2 than in period 1. Cumulative incidence functions for the cardiorespiratory mortality compared to non-cardiorespiratory causes are shown in Fig. 2. Cumulative incidence of mortality due to cardiorespiratory causes rose steeply to around 100 days after surgery and then flattened reaching approximately 12% by one