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Factors influencing survival following hip fracture among octogenarians and nonagenarians in the United States

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ABSTRACT

Introduction: Hip fractures account for a significant disease burden in the Unites States. With an aging population, this disease burden is expected to increase in the upcoming decades.
Materials and methods: This represents a retrospective cohort study to assess mortality following hip fracture in the octogenarian and nonagenarian populations. Odds ratios for postoperative mortality were constructed using normalized patients from United States Social Security death tables. Kaplan Meier analysis and binary logistic regression were used to assess the impact of surgical delay and medical comorbidity (measured by the Carlson Comorbidity Index (CCI)) on postoperative mortality.
Results: 189 octogenarians and 95 nonagenarians were included. One-year mortality was nearly three times higher for both the octogenarians (OR: 3.1) and nonagenarians (OR: 3.14), and returned to that of the normal population 4 years post-op for octogenarians and 5 years post-op for nonagenarians. Higher preoperative medical comorbidity (CCI) was associated with higher post-op mortality for both octogenarians (log rank = 0.026) and nonagenarians (log rank = 0.034). A 48-h surgical delay resulted in significantly increased postoperative mortality among healthy patients (CCI of 0 or 1, OR: 18.1), but was protective for patients with significant medical comorbidity (CCI $\geq$ 3). Age, preoperative CCI, and 48-h surgical delay were all independent predictors of 1-year post-op mortality.
Conclusions: Following hip fracture, there is a 3-fold increase in mortality for octogenarians and nonagenarians at 1 year post-op. A 48-h surgical delay significantly increased mortality for healthier patients but was protective against mortality for sicker patients.

Introduction

Hip fractures are an important public health concern worldwide [1,2]. In the United States alone, it is estimated that over 250,000 hip fractures occur annually [3]. These fractures are associated with significant morbidity and mortality, with a 15–30% 1-year mortality rate and an even higher percentage of patients experiencing long term functional deficits [1,4,5]. Furthermore, with an increasingly aging population in the United States, this disease burden is expected to increase over the next few decades [6,7]. Given the substantial cost of immediate and long term treatment of hip fractures, it is imperative to understand patient outcomes in the older population in order to optimize patient management [8,9].

Surgical intervention is the gold standard of hip fracture management and factors such as timing to surgical fixation and coexisting medical comorbidity must be considered in the treatment plan [3,10,11]. It is generally accepted that prompt surgical fixation of a hip fracture correlates with improved patient outcomes and decreased mortality post-operatively [3]. Furthermore, increasing age has been associated with increased mortality following hip fractures, particularly in patients with significant medical comorbidity [12,13,14]. While outcomes following surgical fixation of hip fractures have been extensively investigated, relatively little has been investigated in the United States with regard to the octogenarian (ages 80–89) and nonagenarian populations (ages 90–99), a subset of the elderly population that is expected to expand in upcoming years [15,16,17–19]. The purpose of this study is to investigate the factors which may influence survival in octogenarians and nonagenarians following hip fracture. Specifically, we believe that increasing age, baseline medical comorbidity, and surgical delay would all increase postoperative mortality in this geriatric subset following hip fracture surgery.

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Materials and methods

Data collection

Institutional review board (IRB) approval was obtained prior to initiation of this study. We performed a retrospective cohort study to assess mortality and the factors that influence it following hip fracture in the octogenarian (defined as patients aged 80–89) and nonagenarian (defined as patients aged 90–99) populations. All patients aged 80–99 that had been admitted to a level-one tertiary care trauma center from October 2010 to April 2014 following hip fracture were retrospectively reviewed. Patients met inclusion for the study if they sustained a femoral neck fracture, an intertrochanteric fracture, or subtrochanteric fracture that ultimately underwent surgical intervention. Patients were excluded if they did not undergo surgical intervention or if they passed away prior to surgical intervention. At the institution where this study was conducted, there is a geriatric co-management program which assists in perioperative optimization of patients older than 65.

Outcome variables

The primary outcome for this study was mortality, assessed at yearly intervals following surgical intervention with a particular emphasis on one-year and five-year survival for octogenarians and nonagenarians. Mortality was assessed using death records both from the electronic medical record (EMR) and from publicly available death records available online. Patients were considered lost to follow-up if they had not presented to a medical health professional in the two months prior to data analysis (documented in the medical record) and if there was no publicly documented death record at that time. In order to assess which variables had the largest influence on mortality, gender, age, fracture type, and delay in surgical intervention were all analyzed. Surgical delay was assessed for waits greater than 24 h and greater than 48 h. Finally, individual medical comorbidities were collected using medical consultation notes prior to surgical intervention and preoperative Charlson Comorbidity Index (CCI) scores were subsequently calculated for each patient as a global measure of health status [29].

Statistical analysis

For both octogenarians and nonagenarians, annual mortality was calculated at yearly intervals (up to five years) following hip fracture, and odds ratios were calculated using the United States Social Security actuarial survival for standardized octogenarians and nonagenarians [30]. Kaplan Meier analyses was performed in order to assess survival following hip fracture stratified both by the CCI and by surgical delay (24 h and 48 h) with log rank testing to assess significance. Odds ratios with corresponding 95% confidence intervals (CI) were calculated for mortality at one and five years. Differences in patient demographics for octogenarians and nonagenarians were assessed using chi square testing. Finally, binary logistic regression for 1-year mortality was used to assess which factors had the largest influence on mortality. A cutoff of $p = 0.05$ was used to determine significance for all tests (SPSS Statistics V21.0, IBM Corporation, Armonk, NY, USA).

Results

Of the 389 hip fractures observed over the study period, 105 patients were aged between 60 and 79, and therefore excluded. A total of 189 octogenarians (Average age: 84.9 years, SD: 2.9 years) and 95 nonagenarians (Average age: 92.7 year, SD: 2.6 years) were included in this study (Table 1). Consistent with known life expectancies in the United States, females with a hip fracture comprised a statistically greater proportion of the nonagenarian population (83.2%) compared to the octogenarian population (78.3%). Intertrochanteric fractures were the most common fracture type in both octogenarians (48.7%) and nonagenarians (54.7%). There was no significant difference in the distribution of fracture types or baseline medical comorbidity (measured by the CCI) between the octogenarians and nonagenarians.

Table 1
Baselines patient demographics for octogenarians (ages 80–89) and nonagenarians (ages 90–99).

	Octogenarians	Nonagenarians	$P-$ value
Age (Average ± SD)	84.9 ± 2.9 years	92.7 ± 2.6 years	
Gender			
Male	54 (21.7%)	16 (16.8%)	0.02
Female	148 (78.3%)	79 (83.2%)	
Fracture Types			
Subtrochanteric	19 (10%)	3 (3.2%)	0.1
Femoral neck	78 (41.3%)	40 (42.1%)	
Intertrochanteric	92 (48.7%)	52 (54.7%)	
CCI			
0	48 (25.4%)	24 (25.3%)	0.3
1	43 (22.8%)	29 (30.5%)	
2	41 (21.7%)	23 (24.2%)	
≥3	57 (30.1%)	19 (20.0%)	

SD: Standard Deviation.
CCI: Charlson Comorbidity Index.

There were 3 (1.6%) instances of inpatient mortality following fixation, all among the octogenarian group. As shown in Fig. 1, the 1-year mortality was nearly three times higher for both the octogenarians (OR: 3.1, 95% CI: 2.2–4.4, $p < 0.001$) and nonagenarians (OR: 3.14, 95% CI: 2.1–4.7, $p < 0.001$) after sustaining a hip fractures compared to the normal population. The mortality rate following hip fracture returned to the expected annual mortality rate (95% confidence interval for odds ratio including 1) after 4 years post-operatively for octogenarians and 5 years for nonagenarians (Fig. 1).

Medical comorbidity

As shown in Fig. 2, a higher preoperative Charlson Comorbidity Index was associated with higher mortality rates following hip fracture for both octogenarians (log rank = 0.026) and nonagenarians (log rank = 0.034). Octogenarians with a preoperative CCI ≥ 3 had an increased mortality at both 1 year (OR: 2.06, 95% CI: 1.03–4.1, $p = 0.04$) and 5 years (OR: 4.57, 95% CI: 2.4–8.6, $p < .001$) postoperatively. Similarly, nonagenarians with a preoperative CCI ≥ 3 had an increased mortality at 1 year (OR: 5.38, 95% CI: 1.7 −16.6, $p = 0.0034$) but not 5 years (OR: 2.27, 95% CI: 0.5–10.9, $p = 0.3$). It should also be noted that 5-year survival among nonagenarians was markedly low among all groups.

Surgical delay

As shown in Fig. 3, postoperative mortality following hip fracture surgery appeared to be dependent on baseline medical comorbidity. That is, when grouping octogenarians and nonagenarians, a surgical delay of 48 h resulted in a significant increased postoperative mortality among patients with a CCI of 0 or 1 (log rank = 0.016). On the contrary, patients with a CCI ≥ 3 had improved cumulative survival (although not significantly, log rank = 0.161) when undergoing a delay of 48 h (Fig. 3). More specifically, a delay of 48 h among the octogenarians resulted in a ten-fold increase in 1-year mortality (OR: 10.6, 95% CI: 2.1–53.3, $p = 0.0043$), while a delay of 24 h did not significantly impact 1-

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