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Hemiarthroplasty for Femoral Neck Fracture in the Nonagenarian Population: A Comparative Study on Survival Outcomes

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Purpose: The study aimed to assess the impact of age and comorbidities on mortality in patients with femur neck fractures, focusing on those individuals aged over 90 years. The objective was to determine if chronological age alone defined frailty and if a dedicated hip fracture unit would improve patient outcomes.
Materials and Methods: The retrospective study was conducted over 16 months (January 2017 to April 2018), and included patients undergoing hemiarthroplasty, categorized into Group 1 (aged <90 years) and Group 2 (aged 90 years and above). Detailed data were collected on demographics, mobility, co-morbidity, operative aspects, delays, and mortality. Statistical analysis employed IBM SPSS ver. 25.0, utilizing Mann–Whitney U, Fisher exact, and chi-squared tests with a significance level of <0.05.
Results: Of the 203 patients in our study cohort, 151 were in Group 1, and 52 in Group 2. A significant correlation between high American Society of Anesthesiologists (ASA) grade and mortality after one year (P=0.028) was revealed by logistic regression. Spearman test indicated a positive correlation (0.354) between Charlson comorbidity index scores and ASA grades. Compared to Group 1, Group 2 showed no significant decrease in survival at any studied time point.
Conclusion: Patients over 90 years did not represent a uniquely high-risk subset. Frailty was not defined solely by chronological age; a combination of comorbidities and biological age influenced survival rates. The study reinforced that treatment in dedicated hip fracture units and adherence to established guidelines, led to positive outcomes, and reduced mortality, irrespective of age groups.

Keywords: Femoral neck fractures, Hip fractures, Hip, Elderly, Hemiarthroplasty

INTRODUCTION

Femur neck fracture is a debilitating injury which commonly occurs in extremely old and medically vulnerable patients. In the UK, the Office for National Statistics has reported that the median age at death was 82.3 years for males and 85.8 years for females, making this injury a common occurrence due to increased life expectancy in the last decade[1]. Intracapsular femur neck fractures represent 50% of all hip fractures[2] and hemiarthroplasty is a widely used technique to treat this injury. Despite the best treatment efforts, there is over a 30% mortality rate at one year following hemiarthroplasty, as previously reported by

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various studies around the world[3,4]. As such, this injury ranks as one of the top ten causes of morbidity and mortality in the elderly[2]. Prompt and early surgical intervention within 36 hours of injury has been recommended to achieve faster recovery and regain mobility[5].

This study was conducted in a high-volume hip fracture unit where, along with orthogeriatric expertise, best practice protocols and evidence-based guidelines are followed to effectively treat this vulnerable group of patients. Our study reports on the impact of age and co-morbidities on mortality following hemiarthroplasty for femur neck fractures in the extremely old or over 90 years of age patient group.

The objective of the study was to determine if frailty was defined solely by chronological age and if a dedicated hip fracture unit improved patient outcomes in the nonagenarian population.

MATERIALS AND METHODS

This is a retrospective study of patients presenting with femur neck fractures at Wythenshawe Hospital, Manchester, UK over a 16-month period (from January 2017 to April 2018). The criteria for study inclusion were patients of both sexes, presenting with femur neck fractures which were treated with hemiarthroplasty, within the aforementioned period. Exclusion criteria were patients with pathological fractures, and fractures treated non-operatively, with total hip arthroplasty, or internal fixation. Our patient cohort was restricted to those who underwent hemiarthroplasty, as this is a common procedure performed by all grades of orthopedic surgeons. The categories of collected data were age at presentation, sex, comorbidities, smoking and alcohol history, pre-injury outdoor mobility and accommodation, Charlson comorbidity index (CCI)[6], the American Society of Anesthesiologists (ASA) grade[7], Abbreviated Mental Test Score (AMTS)[8], cementation, unipolar versus bipolar, delay to surgery, the reason for surgical delays, injury side, discharge location, discharge date, mortality date, 30-day mortality, one-year mortality, five-year mortality, and greater than five years mortality.

Statistical analysis was performed using IBM SPSS software for Windows (ver. 25.0; IBM Corp.). Using IBM SPSS, pre-injury and post-surgery outcomes of Group 1 and Group 2 were compared. The results are expressed in measures of average (mean and median) and spread (standard deviation [SD] and interquartile percentages). Continuous non-parametric data comparisons were made using Mann–Whitney U test. Fisher exact and chi-squared tests provided analysis of categorical data. The statistical significance of the results was determined by a *P*-value of <0.05.

Patient health prior to surgery was assessed using the CCI and the ASA classification. CCI creates a weighted percentage for 10-year survival rates based on the number and severity of comorbidities as well as patient age. Postoperative mortality rates were predicted using this index. The ASA classification system was used to grade patients on their fitness level prior to surgery. These two variables were analyzed by a linear regression analysis to determine the relationship between medical fitness and comorbidities with mortality. The length of hospital stay was defined as the time of presentation to the time of discharge from an acute surgical ward to a rehabilitation unit or home. Those who succumbed during hospital admission were excluded from this calculation. In this study, mortality was defined at 30 days, one year, five years, and more than five years after surgery.

RESULTS

A total of 203 patients with intracapsular femur neck fractures underwent hemiarthroplasty in our hospital between January 2017 and April 2018. The mean age of the patients was 84 years, with a minimum age of 57 years and a maximum of 99 years (SD, 7.646). Patients were subsequently grouped into two groups. In Group 1 (patients aged less than 90 years), patient age ranged from 57 to 89 years. In Group 2 (patients aged 90 years and above), patient age ranged from 90 to 99 years. A total of 151 patients were included in Group 1 (<90 years) and 52 patients were included in Group 2 (aged 90 years and above). The baseline variables of both groups have been listed in Table 1.

The AMTS was used to assess patients for delirium. Group 1 patients had a median result of while Group 2 patients had a median result of 5.79 (Table 2, 3). There was no statistical difference between the two groups (*P*=0.174). The majority of patients presenting with femur neck fractures had complex comorbidities, resulting in prolonged hospital stays and higher postoperative complication rates. Patients in Group 1 had a mean number of comorbidities of 2.52, compared to a mean of 2.53 for Group 2 (Table 2, 4). The mean number of comorbidities for the entire cohort was 2.51 which showed no statistical significance (P=0.520)

The American Society of Anesthesiology (ASA) score was recorded for each patient prior to surgery. The mean ASA score for Group 1 was 3.31 and the mean for Group 2 was 3.06. The mean ASA grade of a patient admitted with a femur neck fracture in the entire cohort was 3.12 (SD, 0.660). This was comparable to the ASA grades analyzed per age group using the Mann–Whitney test, and results were insignificant (P=0.078). Using the CCI comorbidities were evaluated to give a more realistic insight into the impact on mortality of the different comorbidity combinations, rather than simply looking at the count. The mean CCI number of 5.28 points, giving a 26.1% ten year estimated survival for the entire cohort, showed no variance between the groups. During analysis of pre-established osteoporosis, it was found that 25.8% (39/151) of patients in Group 1 had diagnosed osteoporosis, whereas only 17.3% (9/52) in Group 2 had a diagnosis. Furthermore, 55.6% (84/151) of patients in Group 1 had significantly impaired mobility which had prevented them from going outdoors with or without mobility aids prior to their injury. Only 44.2% (23/52) of Group 2 had no outdoor mobility pre-injury. This difference also was not significant (P=0.198) (Table 5).

Among the 203 patients in the study, 20 patients (9.9%) were excluded from calculations for length of stay as they succumbed during their hospital admission. Of the 20 deceased patients, 12 were from Group 1 and 8 from Group 2. The length of hospital stay of those who survived to discharge ranged from a minimum of six days to a maximum stay of 221 consecutive days in hospital. The mean length of hospital stay for patients in Group 1 was 14.50 days (P_{25}=7.00, P_{75}=33.75), compared to a mean of 12.50 days (P_{25}=3.25, P_{75}=25.00)

Table 1. Demographics of the Two Groups

Variable	Age group	
	Group 1 (n=151)	Group 2 (n=52)
Sex		
Female	100 (66.2)	41 (78.8)
Male	51 (33.8)	11 (21.2)
Fracture side		
Left	80 (53.0)	31 (59.6)
Right	71 (47.0)	21 (40.4)
Smokes cigarettes	30 (19.9)	0 (0)
Drinks alcohol	22 (14.6)	3 (5.8)
Died in hospital	12 (7.9)	8 (15.4)

Values are presented as number (%).
Group 1: aged <90 years, Group 2: aged ≥90 years.

Table 2. Abbreviated Mental Test Score (AMTS) and Comorbidity Count for Two Groups

Variable	Age group	
	Group 1 (n=151)	Group 2 (n=52)
AMTS		
Severe (0-3)	40 (26.5)	21 (40.4)
Moderate (4-6)	13 (8.6)	3 (5.8)
Mild (7-8)	23 (15.2)	4 (7.7)
Normal state (9-11)	75 (49.7)	24 (46.2)
Comorbidity count		
0 or 1	40 (26.5)	8 (15.4)
2 or 3	70 (46.4)	32 (61.5)
4 or 5	35 (23.2)	12 (23.1)
6 or 7	5 (3.3)	0 (0)
8	1 (0.7)	0 (0)

Values are presented as number (%).
Group 1: aged <90 years, Group 2: aged ≥90 years.

Table 3. Mann–Whitney U Test for American Society of Anesthesiologists (ASA) Grades of the Two Groups

ASA grade	Age group		Total (n=203)	Median (P_{75}-P_{25})
	Group 1 (n=151)	Group 2 (n=52)		
1 (healthy patient)	2 (1.0)	0 (0)	2 (1.0)	3.00 (3.00-4.00)
2 (mild systemic disease)	22 (10.8)	5 (2.5)	27 (13.3)	
3 (severe systemic disease)	92 (45.3)	26 (12.8)	118 (58.1)	
4 (life-threatening systemic disease)	35 (17.2)	21 (25.6)	56 (27.6)	
5 (not expected to live without operation)	0 (0)	0 (0)	0 (0)	
6 (brain-dead organ donation operation purpose)	0 (0)	0 (0)	0 (0)	

Values are presented as number (%).
Group 1: aged <90 years, Group 2: aged ≥90 years.

Table 4. Table of Comorbidities of Two Groups

Co-morbidity	Age group		Total (n=203)
	Group 1 (n=151)	Group 2 (n=52)	
Dementia	53 (35.1)	19 (36.5)	72 (35.5)
Hypertension	61 (40.4)	23 (44.2)	84 (41.4)
Diabetes mellitus	28 (18.5)	5 (9.6)	33 (16.3)
Cardiovascular accident	19 (12.6)	9 (17.3)	28 (13.8)
Cancer	27 (17.9)	10 (19.2)	37 (18.2)
Myocardial infarction	29 (19.2)	11 (21.2)	40 (19.7)
COPD	22 (14.6)	5 (9.6)	27 (13.3)
Chronic kidney disease	6 (4.0)	5 (9.6)	11 (5.4)
Ischemic heart disease	29 (19.2)	14 (26.9)	43 (21.2)
Hypotension	8 (5.3)	3 (5.8)	11 (5.4)
GORD	2 (1.3)	3 (5.8)	5 (2.5)
Osteoporosis	39 (25.8)	9 (17.3)	48 (23.6)
Pulmonary embolism	6 (4.0)	2 (3.8)	8 (3.9)
Asthma	7 (4.6)	0 (0)	7 (3.4)
Bronchiectasis	5 (3.3)	0 (0)	5 (2.5)
Postherpetic neuralgia	1 (0.7)	0 (0)	1 (0.5)
AAA	4 (2.6)	1 (1.9)	5 (2.5)
Depression	7 (4.6)	2 (3.8)	9 (4.4)
Hypercholesterolemia	11 (7.3)	4 (7.7)	15 (7.4)
Anaemia	4 (2.6)	1 (1.9)	5 (2.5)
Cervical spondylosis	4 (2.6)	0 (0)	4 (2.0)
Diverticulitis	5 (3.3)	0 (0)	5 (2.5)
Crohn's disease	2 (1.3)	0 (0)	2 (1.0)
Liver cirrhosis	3 (2.0)	0 (0)	3 (1.5)
Polymyalgia rheumatica	2 (1.3)	2 (3.8)	4 (2.0)
Rheumatic fever	1 (0.7)	0 (0)	1 (0.5)
Polio	1 (0.7)	0 (0)	1 (0.5)
Non-Hodgkin's lymphoma	1 (0.7)	0 (0)	1 (0.5)
Schizophrenia	3 (2.0)	0 (0)	3 (1.5)
Hearing loss	3 (2.0)	6 (11.5)	9 (4.4)

Values are presented as number (%).
Group 1: aged <90 years, Group 2: aged ≥90 years.
COPD: chronic obstructive pulmonary disease, GORD: gastrooesophageal reflux disease, AAA: abdominal aortic aneurysm.

Table 5. Mann–Whitney U Test to Analyse ASA, CCI, AMTS, Comorbidity Count, Pre-injury Outdoor Mobility of Two Groups

Variable	Age group		*P*-value
	Group 1 (n=151)	Group 2 (n=52)	
ASA			
1 or 2	24 (15.9)	5 (9.6)	0.359
3 or 4	127 (84.1)	47 (90.4)	0.359
CCI (10-year survival probability)			
0-2 (95%)	2 (1.3)	0 (0)	0.156
3 (77%)	12 (7.9)	0 (0)	
4 (53%)	40 (26.5)	14 (26.9)	
5 (21%)	49 (32.5)	18 (34.6)	
6 (2%)	22 (14.6)	8 (15.4)	
>6 (0%)	26 (17.2)	12 (23.1)	
Pre-injury outdoor mobility			
Mobile outside	84 (55.6)	23 (44.2)	0.198
Not mobile outside	67 (44.4)	29 (55.8)	

Values are presented as number (%).
Group 1: aged <90 years, Group 2: aged ≥90 years.
ASA: American Society of Anesthesiologists, CCI: Charlson comorbidity index, AMTS: Abbreviated Mental Test Score.

Table 6. Chi-squared Test to Compare American Society of Anesthesiologists (ASA) Grade and Mortality

ASA grade	Time points for patient cumulative mortality			
	30-day mortality		One-year mortality	
	Death (n=8)	*P*-value	Death (n=60)	*P*-value
1	0 (0)	0.423	0 (0)	0.001*
2	0 (0)		1 (1.7)	
3	4 (50.0)		33 (55.0)	
4	4 (50.0)		26 (43.3)	
5	0 (0)		0 (0)	
6	0 (0)		0 (0)	

Values are presented as number (%).
*P<0.05.

for Group 2.

Mortality after injury was calculated at 30 days, one year, five years, and long-term survival (greater than five years) after injury. There was no statistical difference between the groups in the 30-day survival where 3.9% of patients died in total; 4.0% were from Group 1 and 3.8% were from Group 2 (P>0.999). Within one year, 29.6% of the total patients died. Of this total, 27.2% were from Group 1 and 36.5% were from Group 2 (P=0.220). Within five years of surgery, there was no statistical difference in terms of mortality where 65.0% of total patients died. Of this number, 61.6% were from Group 1 and 75.0% were from Group 2 (P=0.10). Finally, there was no statistical difference (P=0.093) for long-term survival (more than 5 years). For this group, 35.0% of patients had died five or more years post-injury. In this long-term survival group, 38.4% were from Group 1 and 25.0% were from Group 2.

Our study also examined patient groupings based on their ASA grade instead of chronological age. It was determined that patients with higher ASA grades were at increased risk of early mortality and less likely to survive five years post-surgery. It was observed using a logistical regression analysis, that patients with a high ASA grade had a higher one-year mortality rate (P=0.028). Furthermore, there was no statistical significance was noted between a high ASA grade and five-year mortality (P=0.428). Spearman test generated a correlation coefficient, suggesting a weak to moderately positive correlation (0.354). This study also observed a slight trend showing a positive correlation between increased CCI score and ASA grade of a patient before surgery (Table 3, 6).

DISCUSSION

Femur neck fracture is a debilitating injury complicated by comorbidities of the patient population. Managing these injuries require well established and evidence-based pathways with the support of a multidisciplinary team including orthopaedic surgeons, orthogeriatricians, anesthetists, physiotherapists, nursing staff, and other vital health care workers.

Due to their advanced age, patients in Group 2 are conventionally considered to be one of the frailest subsets, making them a challenging subgroup to treat and, owing to several medical comorbidities, resulting in poor outcomes[9]. Extensive studies have looked at the outcomes following femur neck fractures in patients over 85 years of age and labelling them as a unique high-risk subset[9,10]. Due to the deterioration of homeostasis while naturally aging, medical frailty is common in patients greater than or equal to 85 years. However, frailty is a complex multifaceted state that affects patients of various age groups and not exclusively the extremely old[11].

Patel et al.[12] highlighted that certain comorbidities, such as pulmonary disease, renal insufficiency, malignancy, thyroid disease, and altered mental state, would independently modify mortality rates in femur neck fractures. Using the AMTS in our study group, a ten-point metric classification assessing delirium and dementia measured the mental state of a patient prior to surgery. A score of less than or equal to six points suggests the patient is suffering from delirium or dementia[13]. However, in our study, these scores were not statistically significant between the two groups (P=0.174). The CCI scoring system assessed the other comorbidities that each patient had before surgery, which again revealed no preference between age groups (P=0.156). Furthermore, patients in Group 2 (aged 90 years and over) had fewer modifiable risk factors, such as smoking and alcohol consumption. This analysis led to the possibility that patients over 90 years are no different than their younger counterparts.

The results collected from our patient cohort contradict preconceived perceptions[10] of deeming individuals over 85 years as a unique high-risk subset. None of the time points studied revealed femur neck fractures treated with hemiarthroplasty in Group 2 had a significant decrease in survival outcome. Many studies have reported an overall mortality rate of over 30% at one year post-hemiarthroplasty treatment[3,4]. This study found a mean mortality of 29.6% in the same time frame and that the mortality rates of patients who experienced a delay in their surgery in Group 2 were at no greater risk of early mortality at either 30 days or at one-year post-surgery.

Our study suggests, rather than grouping patients by chronological age, a better way of identifying patients with a potential to have a higher chance of one-year mortality would be based on ASA scores. Comparing patients with an ASA score of 1 and 2 with those scoring 3 and 4, there was a clear correlation between those with higher scores resulting in earlier demise. Amongst patients scoring an ASA grade of 1 or 2, none died within 30 days of surgery and only one patient in this group died within a year (1.7%). Patients with an ASA score of 3 or 4 were deemed to have severe systemic disease or life-threatening injury and, of these patients, 98.3% died within one year of surgery. Furthermore, there was a significant correlation between higher CCI scores and high ASA grades. This suggested that the greater the number and severity of comorbidities, the higher the ASA grade.

The preconceived notion of higher age correlating to a higher risk of death might be inaccurate. Functional status before surgery modifies mortality rates[14]. Most patients in Group 2 (90 years and over) had fewer comorbidities making them a relatively healthy cohort. Group 2 patients had fewer modifiable risk factors such as smoking and alcohol consumption. All of the above factors may have contributed towards a long life and reaching this age bracket of 90 years and over. Conversely, the youngest patient in our cohort to undergo hemiarthroplasty was 57 years of age. This patient also had extensive co-morbidities and was unsuitable for any other procedure such as total hip arthroplasty. This further reinforces the importance of the patient's physiological age rather than chronological age playing a vital part in decision-making, outcome, and mortality. Reducing mortality rates and restoring quality of life is imperative while treating this injury.

The study site is a high-volume hip fracture unit with an average case mix adjusted 30-day survival of 98.1%, which is above the national average of 93.6%. In the first quarter of 2023, the case mix adjusted 30-day mortality of our unit was 1.3% against a national average of 6% (data from National Hip Fracture Database). Therefore, a multi-disciplinary approach in a specialized hip fracture unit with well-established pathways can make a large difference in outcomes and mortality in these patients irrespective of their age groups.

A strength of our study was that patients were selected from January 2017 to April 2018, and followed up for a period of six years. This time period provided an accurate representation of long-term follow-up and assessment of more than 5 years mortality. Study limitations include its retrospective nature and limited data pertaining to factors such as duration of surgery, blood loss and time to postoperative mobilization. Our study cohort was obtained from a single high-volume centre. Therefore, it is difficult to assume that our results can be extrapolated to other centres. Unconscious bias associated with patient mortality meant that the specific impact of the treatment on the quality of life or the patient's death was uncertain in each group. Our study did not include patients who underwent total hip replacement for femur neck fracture, which may be the preference of the healthier population under 90 years of age. Thus, our study may exhibit some degree of selection bias, and risks the conclusion that all patients with femur neck fractures are not represented. Lastly, the statistical analysis has been performed as a univariable analysis between the two groups. Stricter control of confounding variables would increase the objectivity of statistical results as each variable can affect mortality rate. To more reliably identify factors affecting mortality, future multicentred studies should be conducted to establish patient treatment with total hip replacements in extremely old individuals with multivariable analysis including factors likely to affect mortality such as age, sex, and comorbidity, as well as the use of the Kaplan–Meier method for survival analysis.

CONCLUSION

Femur neck fracture is a debilitating injury necessitating prompt and early surgical management to ensure a good functional outcome. Our study suggests that patients over 90 years of age do not represent a unique high-risk subset. Frailty is not solely defined by chronological age. A combination of comorbidities and biological age determine chances of survival after this injury. Treatment of these injuries in a dedicated hip fracture unit with established guidelines and pathways can improve outcomes and reduce mortality irrespective of patient age.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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