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Original Article

Concomitant upper limb and hip fractures in older adults - does the site matter? A retrospective clinical observation study

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ABSTRACT

Background: Recent reports have suggested that mortality and morbidity in patients with concomitant upper limb and hip fractures vary depending on the sites of fracture.

Objectives: To determine the mortality outcomes in elderly patients with concomitant upper limb (wrist or humerus) and hip fractures compared to patients with isolated hip fractures. The secondary objective was to determine the length of hospital stay during acute care, morbidity characteristics and perioperative complication rates.

Methods: 144 older adults with concomitant upper limb and hip fractures were compared to 2,690 older adults with isolated hip fractures in a single-centre tertiary hospital. Blinded patient data were extracted from our Inpatient Separation Information System based on ICD-10 codes for analysis and comparison between the groups. A multivariate regression survival analysis was performed to determine mortality outcomes.

Results: No difference in mortality was shown between patient groups in the short and long term. Older adults with concomitant humeral and hip fractures had a higher prevalence of cognitive disorders and chronic kidney disease, while those with concomitant wrist and hip fractures had the lowest. Those with concomitant upper limbs fracture had a longer length of stay during the acute care, as well as a greater requirement for blood transfusions.

Conclusions: When compared to isolated hip fracture patients, older adults with concomitant hip and humeral fractures may represent a frailer group, but not necessary in those with concomitant hip and wrist fractures.

BACKGROUND

Hip fracture is common among the frail geriatric population and has a poor prognosis with high rates of mortality,[1] functional decline,[2,3] and institutionalization.[4] In rare instances, some older adults suffer upper limb fractures along with hip fractures as a result of a single fall, most commonly the wrist and humerus.[5-8] Recent reports have demonstrated a longer length of hospital stay in both acute and rehabilitation settings after hip fractures with concomitant upper limb fractures.[5-7] However, functional recovery has been found to be poorer only in hip fracture patients with concomitant humeral fractures; conversely, similar or better prognoses were observed in patients with concomitant wrist fractures when compared to isolated hip fracture patients.[6] Robinson et al. described a trend towards higher mortality only in those with concomitant humeral fractures but not wrist fractures.[5] This dichotomy requires further exploration, given previous studies were not designed nor powered to explore the implications of the different concomitant upper limb fractures on mortality and morbidity outcomes.

The aim of this study was to assess the impact of concomitant wrist or humeral fractures with hip fractures, compared with isolated hip fracture, in older adults.

METHODS

Study Design, Participants, and Setting

Flinders Medical Centre is a 580-bed public tertiary hospital in Adelaide, South Australia. It has an orthopaedic surgical unit supported by an embedded orthogeriatric service. We performed a retrospective observational study of older adults aged 65 years and over admitted with a hip fracture, with or without concomitant wrist or humeral fractures between 1st January 2003 and 31st December 2013. Other types of fractures (other upper limbs, vertebra, pelvic,

Table 1. Patient characteristics, comorbidities and perioperative complications

Patient Characteristic	**Isolated hip fracture (*n* = 2,690)**	**Hip + Wrist (*n* = 81)**	**Hip + Humerus (*n* = 63)**	***P-value*[#]**
Age, mean (SD)	84 (7.4)	83 (8.8)	84 (8.2)	0.38
Female to male ratio	*3:1*	*6:1*	*5:1*	*0.01*
Charlson Comorbidity Index, median (Interquartile range)	*1 (0, 2)*	*0 (0, 1)*	*1 (0, 2)*	*<0.01*
Comorbidities	**Isolated Hip Fractures**	**Hip + Wrist**	**Hip + Humeral**	***P-value*[#]**
Cardiovascular	1086 (40.4%)	31 (38.3%)	29 (46.0%)	0.61
Respiratory	643 (23.9%)	18 (22.2%)	19 (30.2%)	0.48
*Cognitive disorder**	*695 (25.8%)*	*16 (19.8%)*	*25 (39.7%)*	*0.02*
Endocrine	454 (16.9%)	9 (11.1%)	12 (19.0%)	0.35
Cerebrovascular accident	128 (4.8%)	3 (3.7%)	2 (3.2%)	0.77
MSK	469 (17.4%)	18 (22.2%)	10 (15.9%)	0.55
Neurological	87 (3.2%)	1 (1.2%)	1 (1.6%)	0.46
Diabetes	391 (14.5%)	7 (8.6%)	11 (17.5%)	0.26
Chronic kidney disease	*617 (22.9%)*	*16 (19.8%)*	*25 (39.7%)*	*<0.01*
Previous osteoporotic fracture	290 (10.8%)	11 (13.6%)	4 (6.3%)	0.38
Visual impairment	60 (2.2%)	2 (2.5%)	2 (3.2%)	0.88
Peripheral vascular disease	98 (3.6%)	5 (6.2%)	2 (3.2%)	0.48
Neoplasm	93 (3.5%)	1 (1.2%)	2 (3.2%)	0.55
Perioperative complications				
Delirium	264 (9.8%)	6 (7.4%)	7 (11.1%)	0.72
Urinary tract infection	370 (13.8%)	11 (13.6%)	14 (22.2%)	0.16
Pneumonia	335 (12.5%)	12 (14.8%)	10 (15.9%)	0.60
Myocardial infarction	175 (6.5%)	5 (6.2%)	5 (7.9%)	0.89
Heart failure	280 (10.4%)	7 (8.6%)	6 (9.5%)	0.86
Arrhythmia	375 (13.9%)	11 (13.6%)	14 (22.2%)	0.17
Pressure sore	74 (2.8%)	0 (0.0%)	2 (3.2%)	0.31
Surgical site infection	293 (10.9%)	4 (4.9%)	6 (9.5%)	0.22
VTE	4 (0.1%)	0 (0.0%)	0 (0.0%)	0.90
RBC transfusion	*974 (36.2%)*	*37 (45.7%)*	*36 (57.1%)*	*<0.001*

*Cognitive disorder defined as neurodegenerative cognitive disorder such as dementia; [#]P-value for comparison between isolated hip, wrist and humerus. SD, standard deviation; MSK, musculoskeletal; VTE, venous thromboembolism; RBC, red blood cell.

skulls, minor fractures, etc.) were excluded. The mechanism of the fracture (i.e. low-energy vs high-energy impact) was not analysed. We are assuming most were fragility fractures.

Patients were identified from the hospital's Inpatient Separations Information System and categorized into: (1) isolated hip fracture, (2) hip and humeral fractures, and (3) hip and wrist fractures. Patients' age, gender, comorbidities, including the Charlson Comorbidity Index (CCI) based on ICD-10 codes, inpatient complications, length of acute stay, and dates of death were extracted for analysis.

The patients' diagnoses, comorbidities and pre-defined [21] set of most common occurring inpatient complications (delirium, urinary tract infection, pneumonia, myocardial infarction, heart failure, arrhythmia, pressure sore, surgical site infection, venous thromboembolism, blood transfusion) were obtained from clinical coding using ICD-10 codes.

Statistical Analysis

Categorical variables were analysed using the two-tailed chi-squared test. For normally distributed continuous variables, means were compared using two-tailed ANOVA. For non-normally distributed continuous variables, medians were compared using the Kruskal-Wallis test. Survival analysis was performed using the Cox proportional hazards model. Patients were followed from the date of admission to the date of death or the censoring date (16th March 2015). The stepwise procedure (forward

Table 2. Length of hospital stay and mortality rate

Patient Characteristic	Isolated hip fracture (*n* = 2,690)	Hip + Wrist (*n* = 81)	Hip + Humerus (*n* = 63)	*P-value*[#]
Length of hospital stay, median (IQR)	*8.6 (0.1–107.8)*	*10.8 (0.1–46.4)*	*11.4 (0.5–77.5)*	*< 0.001*
Inpatient mortality (%)	141 (5.2%)	4 (4.9%)	5 (7.9%)	0.63
30-day mortality (%)	210 (7.8%)	4 (4.9%)	6 (9.5%)	0.55
One-year mortality (%)	629 (23.4%)	14 (17.3%)	20 (31.7%)	0.13

[#]P-value for comparison between isolated hip, wrist and humerus. IQR, interquartile range.

method) was used to build the model; however, age, sex, hip fracture group, cognitive failure and renal failure were included as a priori factors. Proportional hazards assumptions were examined using Schoenfeld residuals and were used for those variables that did not meet the assumption (age, sex, CCI and pulmonary events). In addition, time-varying coefficients (TVC) were used for a better analysis of time-to-event data and the interrelationships between the outcome and variable over time.

The study was approved by the Southern Adelaide Clinical Human Research Ethics Committee (Application Number 172.15).

RESULTS

A total of 2,834 hip fracture cases were identified during the study period, including 144 patients who suffered concomitant fractures of the wrist (81 patients, 2.9%) or humerus (63 patients, 2.2%) from a single fall. Patient characteristics are outlined in Table 1. There were no significant age differences between groups with an average age of 84 years. Women were more likely than men to have a hip fracture, and this was further accentuated in those with concomitant upper limb fractures. Those with concomitant wrist and hip fractures had the lowest median CCI compared to concomitant humerus and hip, and isolated hip fractures.

Comorbidities and perioperative complications are outlined in Table 1. The prevalence of cognitive disorders and chronic kidney disease (CKD) was highest in those with concomitant hip and humeral fractures and lowest between the concomitant wrist and hip fractures. We found no major differences in perioperative complication rates between the groups, except a greater requirement for blood transfusions in the concomitant upper limb fracture group, especially in those with concomitant humeral fractures.

Those with concomitant upper limb fractures had a longer length of acute hospital stay (Table 2). There were no significant differences in inpatient, 30 day, or one year mortality between the groups. Also, after adjusting for 12 potential confounders using multivariate Cox proportional hazards model analysis, there was no difference in mortality was observed between the groups over longer follow-up (Table 3 & Figure 1).

DISCUSSION

It is often assumed that older adults with hip fractures with concomitant upper limb fractures are frailer and in poorer health. This study has demonstrated that those with concomitant wrist fractures may be a fitter group with respect to comorbidities compared to those with isolated hip fractures, though with longer length of stay because of injury-related disability, and comparable mortality. By contrast, those with concomitant humeral fractures have higher comorbidity and complications, longer lengths of stay, but similar mortality.

No previous studies have examined the effect of hip fracture with concomitant upper limb fracture in hip fracture patients in such a large scale and factored in patient's comorbidities burden and perioperative complications. In this 10-year retrospective cohort study of 2,834 patients, we found no differences in mortality rates between the patient groups in the short or long term, consistent with the findings of Uzoigwe et al. and Buecking et al.[7-8]

We observed a lower prevalence of cognitive disorders and CKD in the concomitant wrist fracture group, and this may partially account for the lower CCI in this cohort.[9.] Similarly, Robinson et al. noted those with concomitant wrist fracture had the highest cognitive and ASA scores, representing a fitter and more agile group, and those with concomitant humeral fracture the lowest.[5] This association between type of fractures and comorbidities may in part be explained by the fracture mechanism and thus pattern of injury in each group. Cummings and Nevitt have postulated

Table 3. Multivariate Cox proportional hazards regression analysis model: association between mortality and concomitant upper limbs fractures in comparison to isolated hip fracture

	Hazard ratio	95% CI	*P-value*[#]
Hip + Wrist (Group B)	1.06	0.77–1.45	0.73
Hip + Humerus (Group C)	1.38	1.01–1.89	0.046
Age	1.07	1.07–1.09	<0.001
Age-TVC	0.99	0.99–0.99	<0.001
CCI	1.22	1.18–1.26	<0.001
CCI-TVC	0.99	0.99–0.99	<0.001
Pulmonary	1.84	1.55–2.21	<0.001
Pulmonary event-TVC	0.99	0.99–0.99	<0.001
Pulmonary event-TVC2	1.00	1	<0.001
Heart failure	1.33	1.15–1.55	<0.001
Male sex	1.36	1.17–1.58	<0.001
Male sex-TVC	0.99	0.99–0.99	0.01
Venous thromboembolism	3.86	1.43–10.37	<0.001
Cognitive disorder	1.17	1.05–1.31	<0.001

CCI, Charlson comorbidity index; TVC, time-varying coefficient.

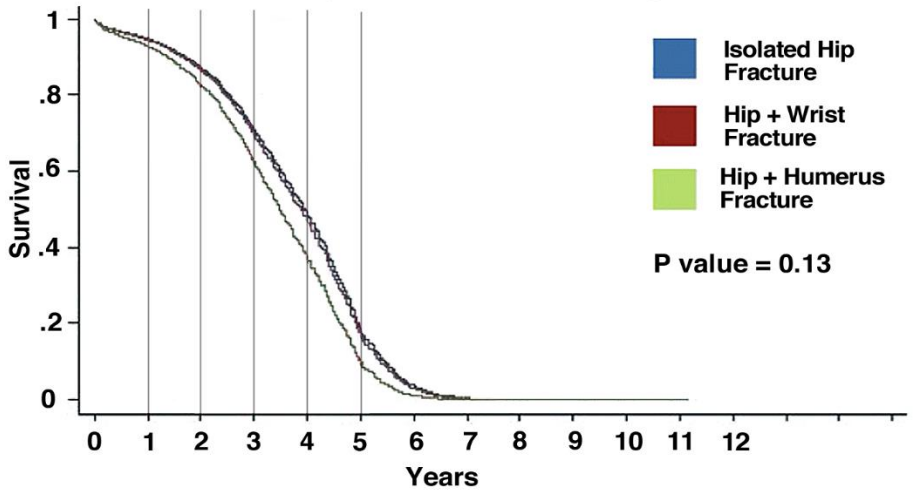

Figure 1. Comparison of survival between the three patient groups.

that the direction of fall, protective response to falling, and the force at the site of impact may influence the pattern of fractures in older adults.[10] The fitter group has better protective reflexes to break a fall with their hand fully extended, and therefore absorbing the force of impact at the wrist. In contrast, older adults with concomitant humeral fractures represent a frailer group with poorer cognition, strength and reflexes and who cannot assume an active protective position to cushion a fall with their arms. Consequently, they often fall sideways or backwards, absorbing the force of impact in the shoulder and hip leads to concomitant hip and proximal humeral fractures.[11] It is noted that both cognitive disorders and CKD are strongly associated with frailty,[12,13] increased risk of falling,[14,15] poorer posture and gait instability.[16,17]

The presence of concomitant upper limb fractures appears to have no implication for perioperative complication rates in hip fracture patients with the exception of blood transfusions. This may be due to the higher prevalence of CKD in our concomitant humeral and hip fractures cohort. CKD is often associated with preoperative low haemoglobin levels,[18] an increased risk of bleeding owing to platelet dysfunction[19] and a high likelihood of cardiovascular disorders and thus lower threshold for transfusion. [20] Thereis limited information in the literature regarding blood transfusions in older adults with concomitant fractures, however this study demonstrated a higher blood transfusion rate (36.2%) in patients with isolated hip fractures compared to those of a recent Australian perioperative hip fracture study (28.4%).[21] However due to the nature of this study, no indication for transfusion was collected, thus appropriateness of transfusion cannot be assessed. Ongoing review of transfusion practices is warranted to ensure ongoing concordance with current evidence-based guidelines.[22]

Regarding acute hospital length of stay, our findings were consistent with other reports[5-8] revealing that older patients with concomitant upper limb fractures had a longer median length of stay compared to isolated hip fracture patients. This can be partly attributed to the greater functional disability of patients with concomitant upper limb fractures[6] as well as the higher blood transfusion rates, which are also associated with longer hospital stays.[23]

We found a preponderance of women among the elderly patients with concomitant upper limb fractures. Similar findings were noted in previous concomitant upper limbs fracture studies;[5-8] this is consistent with higher fracture rates in elderly women due to the higher prevalence of osteoporosis.[24]

Our study has inherent limitations of being a retrospective cohort study based on ICD-10 coding. Limitations include variability in electronic and written records, coder's trainingand experience and coder's error (such as misspecification, unbundling and upcoding).[25] We have not explored the impact of other factors in the perioperative period, nor the nature of the surgical and post-acute care in any of these patients, which may have a confounding effect on mortality and morbidity outcomes.[26]

CONCLUSIONS

Our findings suggest that the presence of concomitant upper limbs fractures in hip fracture patients have no influence on short- and long-term survivorship. However, compared to patients with isolated hip fractures, those with concomitant hip and humeral fractures represent a frailer group. Whilst hip fractures themselves are often a marker of frailty and warrant assessment and intervention, those with concomitant hip and humeral fractures warrant a more aggressive approach to frailty assessment and management.

CONFLICT OF INTEREST STATEMENT

No conflict of interest was declared among authors.

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