

Fragility fractures of the lower limb beyond the hip: A descriptive prospective cohort study

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Dear Editor,

There is an increased recognition that geriatric low-energy lower-limb fragility fractures may have comparatively significant morbidity and mortality as do geriatric hip fractures. Existing literature suggests that these patients may be at least as frail as the geriatric hip fracture population. Recent expansions in orthogeriatric team capabilities have enabled orthogeriatric co-management of these non-hip non-vertebral (NHNV) geriatric lower-limb fragility fractures. Our objective is to characterise this group of NHNV lower-limb fragility fractures, elucidate the benefit of orthogeriatric co-management, and identify predictors of poor outcomes and increased mortality in these patients.

We conducted a prospective cohort study of all NHNV lower-limb fragility fractures in Tan Tock Seng Hospital, Singapore from January 2021 to December 2022. This coincided with the implementation of orthogeriatric co-management of NHNV lower-limb fragility fractures in our institution. The data were obtained from our institutional lower-limb fragility fracture registry that includes patients who meet the following criteria: (1) minimum 60 years of age, (2) admission for an NHNV lower-limb fracture and (3) fall from standing height. Fracture types included femur, tibia, pelvic, acetabular, peri-implant and peri-prosthetic fractures. Baseline demographics including age, sex, fracture location, management modality (surgical or conservative), preoperative Clinical Frailty Scale (CFS), as well as premorbid ambulatory status and aids were collected from clinical charts.

The primary outcome of the study was the 1-year mortality. Secondary outcomes included the rates of acute inpatient medical complications, and the length of acute hospital stay.

The study has obtained institutional ethics approval from the National Healthcare Group Institutional Review Board (2024-3152).

A total of 252 patients with NHNV lower-limb fragility fractures were included in the 2-year prospec-

tive study. Of these, 81.0% of the cohort were females, with a mean age of 77.7 years on admission. Femoral and lower-limb peri-implant/peri-prosthetic fractures were the most common fracture locations (30.6% and 22.2%, respectively). Moreover, 78.2% of patients had a CFS (4 and higher) suggesting frailty. Surgical intervention was the predominant management modality (57.1%). Only 35.2% of the cohort was allowed to fully weight bear as tolerated after intervention, regardless of intervention modality (Table 1).

The mean length of stay for the operated patients was 10.9 days, versus 8.6 days for conservatively treated patients. Time to surgery was short at 2.5 days. The incidence of inpatient medical complications was 17.9%, with the majority being urinary tract infection (UTI). One-year mortality was 11.1% (Table 1).

After excluding 2 outliers, multiple regression modelling of length of stay, complications and 12-month mortality proceeded against age and sex, given significant between-group differences on admission ($P < 0.05$). The model was improved when further regressed against mobility status, CFS group on admission and management modality. Management modality was significantly correlated to length of stay and complications ($P < 0.001$ for both). Surgical management improved the odds of survival at 12 months (odds ratio [OR] 2.06, 95% confidence interval [CI] 0.65–6.53, $P = 0.22$). Allowing weight-bearing as tolerated reduced the length of stay by 3.01 days (95% CI -4.91 to -1.11, $P < 0.001$). Post-operative delirium (OR 9.61 [95% CI 4.38–14.84], $P < 0.001$), stroke (OR 8.63 [95% CI 1.54–15.72], $P = 0.02$) and UTI (OR 3.56 [95% CI 0.41–6.72], $P = 0.03$) were significantly correlated to length of stay. However, none of the complications were correlated to survival at 12 months.

We therefore present the largest-known prospective cohort study on NHNV lower-limb fragility fractures co-managed by an orthogeriatric team. This cohort had high rates of frailty and was skewed towards females, consistent with large prospective cohort

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Table 1. Demographics and 1-year outcomes of non-hip non-vertebral lower-limb fragility fractures.

Demographics	Orthogeriatric care cohort (n=252)
Age, mean (SD)	77.7 (10.0)
Female, no. (%)	204 (81.0)
CFS group, no. (%)	
1–3	55 (21.8)
4–9	197 (78.2)
Location of fracture, no. (%)	
Femur	77 (30.6)
Patella	30 (11.9)
Tibia	33 (13.1)
Ankle	36 (14.3)
Acetabulum	20 (7.9)
Periprosthetic, peri-implant	56 (22.2)
Mobility on admission, no. (%)	
Community ambulant	147 (58.3)
Homebound	105 (41.7)
Level of assisted mobility, no. (%)	
Independent of aid	133 (52.8)
Single arm aid	45 (17.9)
Double arm aid	15 (5.9)
Personal assistance	32 (12.7)
Wheelchair/bedbound	27 (10.7)
Treatment type, no. (%)	
Conservative	108 (42.9)
Operated	144 (57.1)
Weight-bearing status post-intervention, no. (%)	
Non-weight bearing	143 (56.7)
Partial weight bearing (i.e. 50% of weight bearing on affected limb)	23 (9.1)
Weight bearing as tolerated	89 (35.3)
Outcomes	
Length of stay, days; mean (SD)	
Conservative	8.6 (9.9)

Table 1. Demographics and 1-year outcomes of non-hip non-vertebral lower-limb fragility fractures. (Cont'd)

Demographics	Orthogeriatric care cohort (n=252)
Operative	10.9 (7.7)
Total	9.4 (6.5)
Time to surgery, days; mean (SD)	2.9 (2.5)
Inpatient medical complications, no. (%)	
Urinary tract infection	18 (7.1)
Pneumonia	6 (2.4)
Delirium	13 (5.2)
DVT/PE	7 (2.8)
Stroke	3 (1.2)
Acute myocardial infarction	0 (0)
Gastrointestinal bleeding	3 (1.2)
Total incidence	50 (17.9)
Inpatient mortality, no. (%)	5 (2.0)
One-year mortality, no. (%)	28 (11.1)

CFS: Clinical Frailty Score; DVT: deep vein thrombosis; PE: pulmonary embolism; SD: standard deviation

studies including the Canadian Multicentre Osteoporosis Study (CMOS) and Tromsø Study, reporting incidences in females 2–3 times more than that of males.^{1,2} The CMOS also showed that the selectivity of females over males extended to mortality rates. Over the 19-year follow-up, 1 in 15 deaths in women was attributable to an NHNV fracture, compared to 1 in 40 deaths in women attributable to a hip or vertebral fracture. More data are required on the anatomical predilection of NHNV lower-limb fractures. The Global Longitudinal study of Osteoporosis in Women suggests that NHNV lower-limb fractures tend to be more proximal (femur, leg, pelvis and knee).³ The Australian cohort study 45 and up suggests that pelvic and proximal femur fractures are age-dependent, but not ankle and proximal tibia/fibula fractures, where the incidence remained relatively constant with age.⁴

Our study shows that orthogeriatric intervention for these patients is beneficial. Compared with unpublished institutional data before the commencement of orthogeriatric intervention for this cohort,

operated patients had seen an improved length of stay with orthogeriatric co-management from a mean of 12.1 days to 10.9 days, attributable to pre-operative optimisation for anaesthetic fitness, aggressive post-operative delirium care protocol, early mobilisation and removal of urinary catheters. Conservatively managed patients in our study saw a slight increase in their mean length of stay from 5.5 to 8.6 days; this may be confounded by the much more significant proportion of frail patients in our intervention cohort that would have required a longer period of medical optimisation as a result of the injury. In all, despite an intervention cohort that is older and frailer, there was no increase in inpatient or 1-year mortality, while pneumonia rates were quartered. It is a testament to the benefit of orthogeriatric co-management in this cohort. The ultimatum is to validate the orthogeriatric management of lower-limb fragility fractures^{8,9} to have non-inferior mortality and cost benefits compared to hip fractures.⁵⁻⁷

Surgical management of these NHNV lower-limb fragility fractures should be encouraged, having improved the odds of survival at 12 months by 2.06 times in our cohort. Likewise, early and full mobilisation should be encouraged to reduce their length of stay. It is also encouraging that 1-year mortality in this NHNV lower-limb fragility fracture cohort is lower than our local 1-year all-cause mortality of hip fractures, most recently quoted to be 14.5% in a sister institution.¹⁰

In conclusion, this is the largest-known prospective cohort that characterised NHNV lower-limb fragility fractures. This unique cohort is frailer and predominantly female. Orthogeriatric care should be encouraged as standard care in this cohort, and surgical intervention is encouraged for its mortality benefit.

Ethics statement

This study was approved by the National Healthcare Group Institutional Review Board (2024-3152). Waiver of consent was granted as only de-identified data were obtained in a retrospective manner for which patient's confidentiality was not compromised, and no patient was harmed in the process.

Declaration

The authors declare they have no affiliations or financial involvement with any commercial organisation with a direct financial interest in the subject or materials discussed in the manuscript.

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