

Assessing Independent Associations Between Radiographic Thigh Muscle Measurements and One-Year Mortality After Hip Fracture Surgery

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INTRODUCTION: Geriatric hip fractures carry significant mortality and morbidity.¹ Accurate prognostication is essential, as factors such as advanced age, comorbidities, frailty, and particularly sarcopenia increase risk. Yet conventional measures of sarcopenia are often impractical in the acute setting.² Recent research suggests thigh muscle measurements from standard radiographs can serve as a practical proxy for sarcopenia.³ This study aimed to determine whether radiographic thigh muscle measurements are independently associated with one-year mortality in hip fracture patients.

METHODS: Institutional review board approval was attained. All patients aged ≥ 70 years who underwent operative treatment for an isolated hip fracture at two urban Level 1 trauma centers between 2018 and 2020 with preoperative radiographs displaying the distal-and-middle femur were included. Thigh muscle diameter and soft tissue size were measured on anteroposterior (AP) (Figure 1) and lateral radiographs at standardized anatomical landmarks. Multivariate logistic regression was performed between radiographic measurements and one-year mortality. Inter-rater reliability for each measurement was evaluated by calculating Intraclass Correlation Coefficients (ICCs).

RESULTS: 199 patients (median age 85 years, 68% female) were included. The median Charlson Comorbidity Index (CCI) was 4 (IQR 4-7), the Comprehensive Geriatric Assessment-based Frailty Index (CGA-FI, scale 0 to 1) was 0.32 (SD 0.14), and 164 patients (82%) lived at home prior to the injury (Figure 2). The one-year mortality was 22%, consistent with known mortality rates. After adjusting for age, sex, smoking status, pre-injury living situation, the CCI, the CGA-FI, and BMI, a greater thigh muscle diameter on anteroposterior radiographs was associated with lower odds of 1-year mortality (adjusted OR 0.73, 95% CI 0.56-0.96, $p=0.026$) (Figure 3). There was no significant association with thigh muscle diameter on lateral radiographs or with total soft tissue diameter on AP or lateral radiographs. The ICCs demonstrated good-to-excellent reliability for all radiographic measurements.

DISCUSSION: This study found that greater thigh muscle diameter on admission AP radiographs predicted lower one-year mortality after hip fracture, with each additional centimeter associated with a 26% reduction in risk, independent of comorbidities and frailty. This is clinically significant as traditional markers of sarcopenia, which are linked to poor outcomes, typically require advanced imaging or strength testing not always practical in the acute setting.⁴ In contrast, AP radiographs are part of standard care and the measurement demonstrated good interobserver reliability, suggesting potential as a valuable prognostic tool. Importantly, the study found that neither lateral radiograph muscle diameter nor soft tissue size were significantly associated with mortality, diverging from some prior reports.³ One explanation is that lateral imaging may be less reliable due to suboptimal positioning in acute cases, and differing compression of muscle under the patient's weight versus the lateral view. Moreover, the study highlights that soft tissue measurements may be less suitable for prognostication, despite some previous reports suggesting protective effects of subcutaneous fat. The study's limitations include its retrospective design, potential measurement variation from non-standardized radiographs, and a relatively small sample size. Moreover, while no specific cutoff for thigh muscle diameter was proposed, its value likely lies as a continuous variable to complement existing prognostic tools. Future research should focus on refining measurement methods, integrating nutritional and metabolic assessments, evaluating automated measurement approaches, and validating cutoff points to enhance accuracy and applicability in clinical risk stratification.

SIGNIFICANCE/CLINICAL RELEVANCE: This study identifies a simple and widely accessible radiographic marker—thigh muscle diameter on AP radiographs—as a pragmatic and independent predictor of one-year mortality in geriatric hip fracture patients. By identifying a feasible measure that can be obtained early in care, this research has important implications for prognostication, resource allocation, and perioperative management.

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Figure 1. Example of how thigh muscle diameter measurements were obtained from the anteroposterior radiograph. Diameter of thigh muscle (yellow line) and diameter of whole soft tissue envelope (yellow + white lines) were measured 15cm proximal to the adductor tubercle.

	Total, n=199	Survived, n=155	Deceased, n=44	p-value
Age in years, median (IQR)	85 (79-90)	84 (79-90)	85 (81-91)	0.102
Sex, n (%)				
Male	134 (68)	110 (71)	24 (55)	0.001
Female	65 (33)	45 (29)	20 (45)	
Living situation at baseline, n (%)				
Home	164 (82)	131 (85)	33 (75)	0.008
Nursing home or other facility	35 (18)	24 (15)	11 (25)	
Charlson Comorbidity Index, n (%)				
0-1	44 (22)	37 (24)	7 (16)	0.108
2-3	103 (52)	83 (53)	20 (45)	
4-5	52 (26)	41 (26)	11 (25)	
6-7	10 (5)	8 (5)	2 (5)	
CGA-FI, n (%)				
0-0.25	117 (59)	100 (64)	17 (39)	0.136
0.25-0.5	78 (39)	65 (42)	13 (29)	
0.5-1	4 (2)	3 (2)	1 (2)	
>1	11 (6)	8 (5)	3 (7)	
CCI, n (%)				
0-1	103 (52)	83 (53)	20 (45)	<0.001
2-3	65 (33)	53 (34)	12 (27)	
4-5	21 (11)	16 (10)	5 (11)	
6-7	10 (5)	8 (5)	2 (5)	
8-9	10 (5)	8 (5)	2 (5)	
10-11	10 (5)	8 (5)	2 (5)	
12-13	10 (5)	8 (5)	2 (5)	
14-15	10 (5)	8 (5)	2 (5)	
16-17	10 (5)	8 (5)	2 (5)	
18-19	10 (5)	8 (5)	2 (5)	
20-21	10 (5)	8 (5)	2 (5)	
22-23	10 (5)	8 (5)	2 (5)	
24-25	10 (5)	8 (5)	2 (5)	
26-27	10 (5)	8 (5)	2 (5)	
28-29	10 (5)	8 (5)	2 (5)	
30-31	10 (5)	8 (5)	2 (5)	
32-33	10 (5)	8 (5)	2 (5)	
34-35	10 (5)	8 (5)	2 (5)	
36-37	10 (5)	8 (5)	2 (5)	
38-39	10 (5)	8 (5)	2 (5)	
40-41	10 (5)	8 (5)	2 (5)	
42-43	10 (5)	8 (5)	2 (5)	
44-45	10 (5)	8 (5)	2 (5)	
46-47	10 (5)	8 (5)	2 (5)	
48-49	10 (5)	8 (5)	2 (5)	
50-51	10 (5)	8 (5)	2 (5)	
52-53	10 (5)	8 (5)	2 (5)	
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56-57	10 (5)	8 (5)	2 (5)	
58-59	10 (5)	8 (5)	2 (5)	
60-61	10 (5)	8 (5)	2 (5)	
62-63	10 (5)	8 (5)	2 (5)	
64-65	10 (5)	8 (5)	2 (5)	
66-67	10 (5)	8 (5)	2 (5)	
68-69	10 (5)	8 (5)	2 (5)	
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80-81	10 (5)	8 (5)	2 (5)	
82-83	10 (5)	8 (5)	2 (5)	
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190-191	10 (5)	8 (5)	2 (5)	
192-193	10 (5)	8 (5)	2 (5)	
194-195	10 (5)	8 (5)	2 (5)	
196-197	10 (5)	8 (5)	2 (5)	
198-199	10 (5)	8 (5)	2 (5)	

Figure 2. Baseline characteristics of study sample

	n	Adjusted OR	95% CI	p-value
AP radiograph: Diameter of thigh muscle	162	0.73	0.56-0.96	0.026
AP radiograph: Diameter of whole soft tissue envelope	142	0.83	0.65-1.05	0.118
Lateral radiograph: Diameter of thigh muscle	165	1.00	0.77-1.29	0.995
Lateral radiograph: Diameter of whole soft tissue envelope	159	0.95	0.73-1.17	0.652

Figure 3. Multivariate Analysis for One-Year Mortality