Symptomatic Atypical Femoral Fractures Are Related to Underlying Hip Geometry

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Background/Purpose: The objective of this study was to characterize the prefracture proximal femur and hip geometry of a chronic bisphosphonate user group that developed either incomplete or complete atypical femur fractures and to compare the bony anatomy of these patients with two demographically similar patient groups: chronic bisphosphonate users who never developed symptoms and a group of patients who sustained displaced hip fracture. We hypothesized that the preinjury femoral neck-shaft geometry of ultimately symptomatic users would be more varus with greater hip-axis length than comparative groups.

Methods: 53 chronic bisphosphonate users who sustained complete or incomplete atypical femoral fracture ("Atypical Fracture Patients" [AFPs]) were treated between 2004 and 2013 at one institution and a chart review was performed to procure bilateral radiographs captured pre-lesion. Radiographic measurements, using standardized published techniques, were made for neck-shaft angle (NSA), hip axis length (HAL), and center-edge (CE) angle. Radiographic measurements of the AFP group were compared with: (1) asymptomatic chronic bisphosphonate users enrolled in an independent research registry at the same institution ("No Fracture Patients" [NFPs]), and (2) patients who presented to our institution after sustaining displaced intertrochanteric hip fracture (ITF). Reliability of NSA and HAL measurements were compared using three trained independent raters using a random sampling of 30 radiographs.

Results: Radiographs of 53 AFPs were retrieved and compared with 43 NFPs and 64 ITF patients. The radiographic measures and main demographic data are presented in the table. The age and gender of the bisphosphonate groups were similar, but incongruous with the ITF group ($P < 0.001$ and $P < 0.01$, respectively). Duration of bisphosphonate use did not statistically differ between groups (7.9 ± 3.5 vs. 7.7 ± 3.3 years, $P = 0.7$). Regression analysis revealed associations between neck-shaft angle (odds ratio [OR] = 0.89, 95% confidence interval [CI] = 0.81-0.97; $P = 0.01$) and body mass index (BMI) (OR = 1.15, 95% CI =1.02-1.31; $P = 0.03$) with fracture development. Receiver operating characteristic curve analysis determined that a cut-off point for NSA <128.3° yielded 69% sensitivity and 63% specificity for development of atypical femoral fracture. Comparison of radiographic measurements between reviewers revealed a high degree of reliability (NSA ICC [intraclass correlation coefficient] = 0.98, $P < 0.001$; HAL ICC = 0.99; $P < 0.001$).

	Patients #	Age(yrs)*	%Female*	Height(in.)	BMI	NSA(°)*	Hip-Axis(mm.)*	CE Angle(°)*
AFP	53	69.5 [10.1]	96.2	62.6 [3.5]	25.8 [6.7]	126.4 [6.6]	120.3 [11.7]	42.6 [6.2]
NFP	43	68.8 [10.3]	90.7	63.1 [3.1]	23.8 [3.3]	130.3 [5.8]	127.3 [12.4]	45.1 [4.8]
ITF	64	79.9 [12.3]	78.1	63.1[4.0]	24.9 [5.1]	131.1 [5.6]	128.2 [13.4]	45.8 [5.0]

*p≤0.05

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POSTER ABSTRACTS

Conclusion: Differences in proximal femur anatomy may explain predisposition for the development of bony changes and symptoms in chronic bisphosphonate users. While these findings support our hypothesis by associating more varus preinjury hip geometry with later development of atypical femur fracture, we unpredictably found symptomatic patients had shorter preinjury hip axis length.