

## Periprosthetic Atypical Femoral Fractures Exist and are Associated with Duration of Bisphosphonate Therapy

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**Purpose:** At present periprosthetic fractures are excluded from the definition of atypical femoral fractures (AFFs). This study challenges this exclusion by reporting a series of periprosthetic fractures that meet the criteria for AFFs and would otherwise be classified as periprosthetic atypical femoral fractures (PAFFs). The study aims to identify predictors of PAFFs among patients on bisphosphonate therapy and to quantify the complications encountered in their treatment.

**Methods:** Patients presenting to a university teaching hospital with periprosthetic femoral fractures from 2007- 2018 were retrospectively reviewed. Patients with features of AFFs (cases: n = 22; median age 83 years ;range, 44-94; 19 female) and those on bisphosphonate therapy with typical fractures (controls: n = 17; median age 83 years; range, 60-86; 13 female) were identified by 2 observers. Univariate and multivariate analysis was performed to identify predictors of PAFF from: age, gender, BMI [body mass index], type and duration of bisphosphonate therapy and its indication, social deprivation, bone mineral density (T-score), serum calcium, albumin, alkaline phosphatase, and time from primary implant.

**Results:** Interobserver agreement for classification of PAFF was excellent ( $\kappa$  0.944,  $P < 0.001$ ). Univariate analysis demonstrated that compared to controls, patients with PAFFs had higher BMIs ( $28.3 \pm 7.3$  vs  $21.5 \pm 3.1$ ,  $P = 0.001$ ), longer durations of bisphosphonate therapy (median 5.3 years [range, 1-13.9] versus 2.4 years [0.1- 15.4],  $P = 0.04$ ), were less likely to be on alendronate (74% vs 94%,  $P = 0.1$ ) and were more likely to have secondary osteoporosis as an indication for bisphosphonate therapy (18% vs 0%,  $P = 0.089$ ). Multivariate analysis conformed duration of bisphosphonate therapy only as an independent predictor of PAFF ( $R^2 = 0.703$ ,  $P = 0.05$ ). Following initial fracture management (PAFFs: 19/22 fixation, 3/22 revision arthroplasty; typical fractures: 12 fixation, 3 revision arthroplasty, 2 nonoperative), complication rates were higher in PAFFs (13/22, 59%) than in the control group (5/17 [29%],  $P = 0.065$ ). Relative risk of any complication for PAFF compared to controls was 1.73 (0.96-3.11, 95% CI [confidence interval]); for reoperation, 1.39 (0.97 to 1.99); for mechanical failure of fixation, 1.2 (0.89 to 1.65); and for nonunion, 1.15 (0.1-1.45).

**Conclusion:** Atypical femoral fractures do occur in association with prostheses. Longer duration of bisphosphonate therapy is an independent predictor of PAFF in patients sustaining periprosthetic femoral fractures while on bisphosphonate therapy. Complication rates are higher following PAFFs, particularly mechanical failure and nonunion requiring reoperation. Larger numbers are needed to identify other important features in both the etiology and management of this fracture type.