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Surgical outcome of intramedullary nailing in patients with complete atypical femoral fracture: A multicenter retrospective study

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ABSTRACT

Background: Management of atypical femoral fracture on bisphosphonate therapy still remains controversy and is reported high rate of complications. The aim of this study was to evaluate the outcome of intramedullary nailing in patients with atypical femoral fracture who took bisphosphonate more than one year through the multicenter retrospective study.
Methods: We gathered 75 atypical femoral fractures from seven institutions between 2009 and 2014. Among them 46 atypical femoral fractures which met the inclusion criteria was evaluated in this study. The average age was 70.1 years (53–80) and the average duration of bisphosphonate use was 5.1 years (1–15 years). Medical records and radiographs were reviewed to determine time to union, union rate, need for revision surgery, restoration of ambulatory function, and complications.
Results: Twenty-nine (63%) fractures healed within 6 months without complications. The average time to union except two non-union was 24.9 weeks (11–48 weeks). Two patients (4.3%) underwent revision surgery for non-union and there was no implant failure. Thirty-seven (80.4%) patients achieved their pre-fracture ambulatory function at the final follow up.
Conclusions: Although the incidence of delayed bone healing is high in atypical femoral fracture on bisphosphonate therapy even treated with intramedullary nailing, the incidence of revision surgery and implant failure was relatively lower than those of extramedullary devices.

Introduction

Osteoporosis is associated with aging and the incidence is increasing annually with prolonged life expectancies. Fragility fractures associated with osteoporosis could affect patient's life and significantly lower patient's quality of life. Bisphosphonate (BP) has shown to decrease bone resorption and turnover, increase bone mineral density, and also has become widely recognized as a mainstay treatment for osteoporosis and prevention for osteoporotic fractures [1–5]. The efficacy and safety of even long-term (5–10 years) treatment of BP has also been established [6]. Although a task force of the American Society for Bone and Mineral Research (ASBMR) reported that a causal relationship between BP and atypical femoral fractures (AFFs) has been not established [7], recent reports have suggested that prolonged use of BP may be related to severe suppression of bone turnover and lack of targeted remodeling of microdamage, which result in low-energy AFFs [8–15].

Although it has been more frequently reported that BP therapy for osteoporosis is associated with AFFs, the incidence of AFFs is relatively low [16] and information regarding the surgical outcomes of AFFs still remains insufficient [17]. Furthermore, several authors have reported high complications rate including delayed healing, implant failure, and revision surgery [17–19].

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However, these outcomes in previous reports have been reported based on the mixture of surgical methods including mainly intramedullary (IM) and extramedullary devices [17–19].

The purpose of this retrospective multicenter study was to evaluate surgical outcomes following IM nailing in patients with AFFs who took BP therapy more than 1 year and to investigate the relationship between these outcomes and patients' characteristics.

Materials and methods

We reviewed the records of patients undergoing surgical treatment for geriatric femoral fractures at seven institutions between 2009 and 2014, and identified 75 AFFs (71 patients) that met the definition of AFFs by the 2013 ASBMR task force document [7]. For these patients, the following inclusion criteria were applied in the current study; (1) patients must have received BP therapy for at least 12 months before fracture, (2) AFFs must be complete fracture and followed up for at least 6 months or until union or revision surgery following IM nailing. Of 75 AFFs, incomplete fractures (8 cases), short-term (<6 months) follow-up before union (8 cases), patients who were not treated with IM nailing (7 cases), and patients who have not been treated with BP more than at least 12 months (6 cases) were excluded. Finally, the cohort of remaining 46 AFFs (44 patients) was enrolled and evaluated in the current study (Fig. 1). Data including demographics, duration of BP therapy before fracture, injury mechanism, complications, revision surgery, time to union, restoration of walking ability by modified Koval score [20], and medical management of osteoporosis after surgery, were collected.

All patients were female and the mean age at index surgery was 70.1 years (range, 53–80). The body mass index (BMI) averaged 22.9 kg/m^2 (range, 17.8–32.1). There were 15 subtrochanteric fractures (32.6%) and 31 diaphyseal fractures (67.4%). All subtrochanteric fractures and 7 diaphyseal fractures were treated with cephalomedullary nail and remaining 24 diaphyseal fractures were treated with standard interlocking nail. The mean duration of BP therapy before fracture was 5.1 years (range, 1–15) and the mean follow-up period was 20.1 months (range, 6–65). BP was stopped in 21 patients (45.7%), continued in 11 patients (23.9%), and changed into teriparatide injection in 14 patients (30.4%) after index surgery.

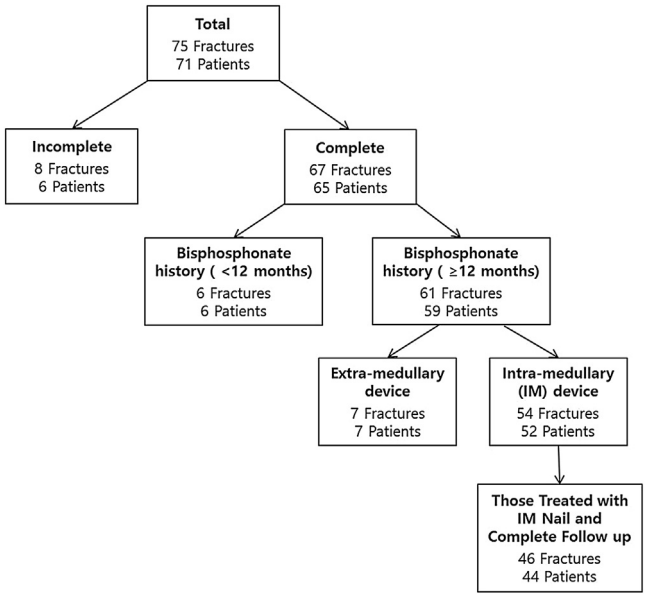

Fig. 1. The flow diagram of patients shows how the final study cohort was determined from our multi-center study registry of bisphosphonate-associated atypical femoral fractures.

The radiologic outcomes were evaluated with union rate, time to union, and complications and radiographic union was defined as callus bridging of three of four cortices on anteroposterior (AP) and lateral radiographs of femur [21]. Delayed healing of fracture was defined as radiographic evidence of union has not been observed until 6 months after surgery. Fixation failure was defined as complete bony union was not achieved up to 1 year after surgery or implant failure such as nail breakage developed during follow up period.

The functional outcome was evaluated using modified Koval score [20] to examine the extent of restoration of pre-fracture walking ability at finial follow up. In addition, we compared patient demographics, duration of BP therapy before fracture, location of fracture, and medical management of osteoporosis after surgery between normal healing and delayed healing groups.

Statistical analysis was performed with SPSS software (version 20.0; IBM Co, Armonk, NY, USA). Chi-square test and Fisher's exact test were used to compare categorical variables and the Student's *t*-test was used to compare continuous variables. The level of significance was $p < 0.05$.

Institutional Review Board approvals were obtained independently at each institution.

Results

Forty-four cases (95.7%) out of 46 achieved complete bony union without any complications and further surgical interventions at the latest follow up (Fig. 2), although delayed union developed in 17 cases. Among 17 AFFs that presented delayed healing of fracture, two AFFs did not united after 12 months after surgery, so were regarded as nonunion and needed further surgical intervention (Fig. 3). The mean time to union except for two nonunions was 24.9 weeks (range, 11–48). Excluding 17 AFFs that presented delayed healing, the mean time to union was 19 weeks (range, 11–24). Thirty-seven patients (84.1%) out of 44 achieved their pre-fracture ambulatory function. There were no complications such as implant failure or infection at the latest follow-up.

There were no statistically significant differences between normal healing and delayed healing groups in terms of age, gender, follow up interval, or duration of BP therapy (Table 1). However, the mean BMI was significantly higher in delayed healing group (24.6 kg/m^2) than normal healing group (22.1 kg/m^2) (p = 0.04). There was also a significant difference in fracture location. There were more subtrochanteric fractures in delayed healing group (52.9%) than normal healing group (20.7%) (p = 0.02). Regarding the effect of medical management after surgery on fracture healing, there was no significant difference in the mean time to union among three groups; BP discontinuation group (n = 20, 26.5 weeks), BP continuation group (n = 10, 28.4 weeks), and teriparatide group (n = 14, 19.7 weeks) (p = 0.08).

Discussion

Although a causal relationship between BPs and AFFs has been not established, a task force of the ASBMR stated that AFFs are more frequent in patients on BP therapy and that longer treatment is associated with higher risk [7]. In this study, all patients had also received BP therapy more than one year and the mean duration of BP therapy was 5.1 years. Several authors have reported that long-term use of BP could severely suppress bone turnover, increase advanced glycated end-products and mineralization, and accumulate microdamage of bone [9,11,12,14]. These contributory mechanisms of AFFs could also affect the adverse effect on bone healing. Teo et al. [18] examined 33 subtrochanteric AFFs on BP that were