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ORIGINAL STUDY

Atypical femur fractures – Patient characteristics and results of intramedullary nailing for a series of 21 patients

Sivaraman SUBRAMANIAN, Martyn J. PARKER

From the Peterborough and Stamford Hospital, NHS Foundation Trust, Peterborough, England

Atypical femoral fractures have been associated with long term use of bisphosphonates. Our study plan was to report the outcome of treatment for a series of patients with an atypical femoral fracture and to compare the characteristics of those patients with a proximal femoral fracture. 21 atypical fractures were identified over a seven year period and these were compared with those of 2.547 hip fracture patients treated over the same time period at a single centre.

The mean age of patients with an atypical fracture was on average nine years less than that for the hip fracture patients (72 as against 81 years, p = 0.002). Four (19.0%) of the patients with atypical fracture had no injury associated with the fracture and nine (42.9%) patients had pain prior to presentation at hospital for a mean of 31 days. Patients with atypical fractures were more likely to be smokers (9/21(42.9%) versus 319/2547 (12.5%), p = 0.0001) and more likely to be on long term oral steroid therapy (8/21 (38.1%) versus 131/2547 (5.1%), p < 0.0001) in comparison to other hip fracture patients.

All the atypical fractures were treated by intramedullary nailing and healed uneventfully apart from one fracture that developed non-union requiring revision nailing. Residual pain at one year from injury was more prevalent for patients with atypical fractures.

Keywords : atypical femur fractures ; bisphosphonates ; patient characteristics.

INTRODUCTION

Bisphosphonates have been shown to reduce the risk of osteoporotic vertebral and non-vertebral fractures (*1,6,8,14*). These drugs prevent bone mass loss by inhibiting osteoclast resorption and this may interfere with bone remodelling (*3,7,11,12*). Bisphosphonates accumulate in high concentration in bone due to binding affinity to calcium (*16,18*). There has been a concern regarding the potential side effects in the form of suppression of bone remodelling which may predispose the bone to atypical fractures. In recent years there has been a gradual increase in the prescription of bisphosphonates therapy (*17*).

Several studies have shown an association between prolonged bisphosphonate use and atypical femoral fracture (*5,10,13*). We present our experience from a single centre for these fractures over a 14 year period. The characteristics of these patients

■ Sivaraman Subramanian.

■ Martyn J. Parker, MD, FRCS.

Peterborough and Stamford Hospital NHS Foundation Trust, Peterborough, England.

Correspondence : Sivaraman Subramanian, Peterborough and Stamford Hospital, NHS Foundation Trust, Department of Orthopaedics, Peterborough City Hospital, CBU PO Box 211 Core C, Bretton Gate, Peterborough PE3 9GZ, England. E-mail : Sivaortho2001@yahoo.co.in

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with an atypical femoral fracture patient were compared with a consecutive series of patients with a proximal femoral fracture (hip fracture).

PATIENTS AND METHODS

Since the original description of bisphosphonate induced atypical femoral fractures in 2007 all such fractures have been recorded on a fracture database at a single centre. The characteristics of these patients were compared with those of 2547 consecutive hip fracture patients admitted over the same time period. Patient fractures were classified as intracapsular, trochanteric and subtrochanteric. All surviving patient were either reviewed in a hip fracture clinic or contacted by phone at one year from injury. At this time pain was assessed on a scale of one (no pain) to six (constant and severe pain) (*4*). and the use of walking aids was recorded. Statistical analysis by Chi squared test, Fisher exact test and t test.

RESULTS

In total 21 atypical fractures were identified (Fig. 1). All patients with an atypical fracture were taking bisphosphonates at the time of admission and had been on treatment for a mean of 6.1 years (range 3-14 years).

Table I details the characteristics of these patients. The patients with atypical fractures were younger than average hip fracture patients, more likely to be smokers or be on oral steroid therapy when compared against patients with a proximal femoral fracture. If the comparison was limited to just subtrochanteric fractures the differences were less marked.

All atypical fractures were treated by closed reduction and intramedullary nailing. A proximal insertion implant was used for 20 patients (Fig. 2) and a retrograde nail for one patient. After surgery all patients were allowed to weight bear as able and discharged home when mobile. Patients were followed up in a hip fracture clinic with a mean radiographic follow-up of 166 days (range 43-365 days). One patient died within one year of injury at 149 days from injury from causes unrelated to the fracture. All but one fracture healed uneventfully. There was a single case of non-union leading to breakage of the nail that required revision nailing.

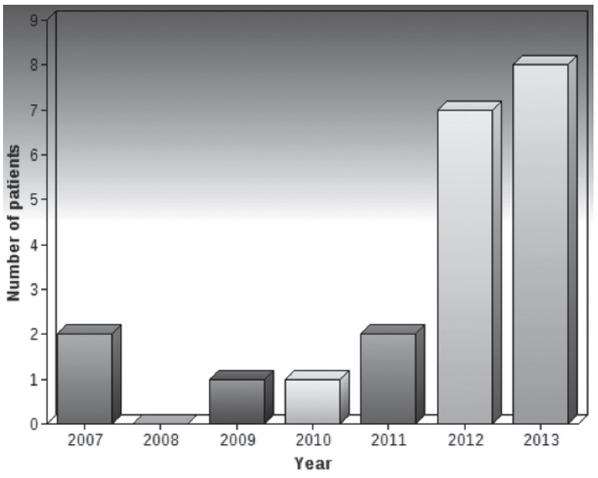

Fig. 1. — Number of patients admitted each year with an atypical femoral fracture.

All atypical fractures had a characteristic fracture pattern with cortical thickening and no comminution at the fracture site (Fig. 2). One fracture was located at the level of the lesser trochanteric with a subtrochanteric extension, 10 were subtrochanteric, nine femoral shaft and one in the distal femur. Nine of the 21 patients had pain at the fracture site for a mean of 31 days preceding presentation for orthopaedic review.

Two patients developed superficial wound infection which settled with antibiotics. One patient developed deep vein thrombosis. There were no other post-operative complications. Table II details the comparison with proximal femoral fractures.

DISCUSSION

This study clearly identified atypical femoral fractures occurred in slightly younger age group compared to fracture neck of femur. Patients with atypical fractures were found to be more likely to smoke cigarettes or to be on steroid therapy than patients with a proximal femur fracture. We also found that the atypical fractures were more likely to have a fracture occurring without trauma and to have a period of pain prior to presentation at hospital.

All the atypical fractures in this study were treated by intramedullary nailing. We had one fracture non-union that lead to breakage of the nail. This fracture was fixed with a statically fixed intramedullary nail with a small gap at the fracture site. The

Table I. — Comparison of patients with an atypical femoral fractures compared to all proximal femoral fracture patients and then to only those with a subtrochanteric fracture. P Value is for the comparison of atypical fractures with those with a proximal femur fracture and then for the subgroup of patients with a subtrochanteric fracture (percentage)

	Bisphosphonates fractures	Proximal femur fractures	p value	Subtrocha-nteric fractures	p value
Patient numbers	21	2547		83	
Mean age [range]	72.4 [29-86]	80.4 [15-106]	0.002 $	77.8 [15-100]	0.15 $
Male sex (%)	3 (14.2%)	703 (27.6%)	0.26 #	30 (36.1%)	0.07 #
Mean ASA grade	2.5	2.6	0.51 $	2.8	0.11 $
ASA grade 1 or 2	10 (47.6%)	1061 (41.6%)	0.74 *	22 (26.5%)	0.07 #
Lives in own home	21 (100%)	2044 (80.2%)	0.046 #	68 (81.9%)	0.04 #
Smoker	9 (42.8%)	319 (12.5%)	0.0001 #	8 (9.6%)	0.001 #
Spontaneous fracture	4 (19.0%)	108 (4.2%)	0.006 #	13 (15.7%)	0.74 #
On steroids	8 (38.1%)	131 (5.1%)	< 0.0001 #	6 (7.2%)	0.001 #

$ = two tailed unpaired t test.
# = Fisher exact test.
* = Chi squared test.

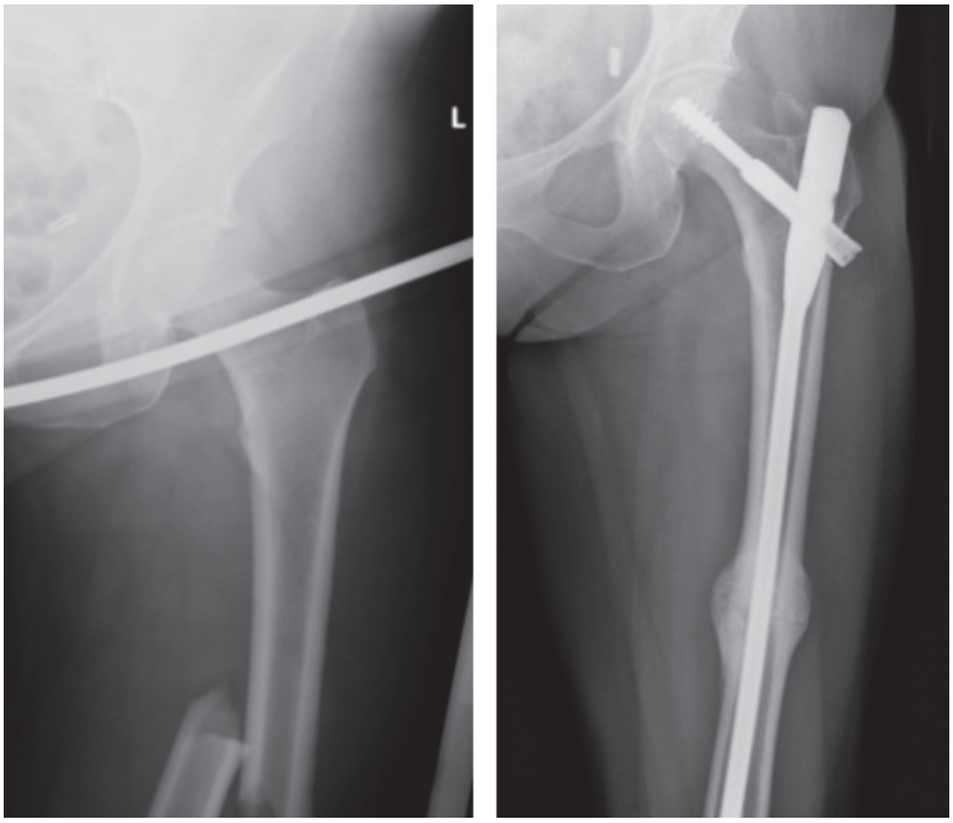

Fig. 2. — Displaced mid femoral shaft fracture with typical configuration thickened cortex at the fracture site, a horizontal fracture line and a small medial 'beak'. The fracture was treated closed reduction and insertion of an intramedullary nail and united in anatomical position.

Table II. — Outcome after treatment for patients with atypical femoral fractures compared to all proximal femoral patients and then to those with a subtrochanteric fracture. P value is for the comparison of atypical fractures with those with a proximal femur fracture and then for the subgroup of paitents with only a subtrochanteric fracture (percentage)

	Bisphosphonates fractures	Proximal femur fractures	p value	Subtrochanteric fractures	p value
Mean days hospital stay	10.3	18.5	0.04 $	22.6	0.003 $
Discharged to same residence	20 (95.2%)	2201 (86.4%)	0.14 #	68	0.18 #
Died at 30 days	0	172 (6.8%)	0.43 #	9 (10.8%)	0.20 #
Died at one year	1 (4.8%)	664 (26.1%)	0.05 #	26 (33.7%)	0.01 #
Mean pain score at one year for survivors	3.1	1.8	<0.0001 $	1.8	0.0002 $
Using the same walking aids at one year	8/15 (53.3%)	925/1751 (52.8%)	1.0 #	26/68 (38.2%)	0.39 #

= Fisher exact test.
$ = two tailed unpaired t test.

authors would recommend a dynamically locked nail for all these fractures to reduce the risk of delayed fracture union. Previous studies have reported high fixation failure rates with these fractures treated with static fixation from femoral plating (*15,20*).

The one year residual pain score was slightly higher in atypical femoral fracture as compared to typical proximal femoral fracture. This may be due to the prolonged fracture union time, poor intramembranous healing and remodelling inhibited by bisphosphonates that has been reported for these fractures (*9,15*). The number of patients using the same walking aids at one year after surgery was more or less similar in both groups.

Our findings suggest that there has been upward trend in the incidence of atypical femoral fractures in recent years which correlates with increasing prescription of bisphosphonates (*17*). Subtrochanteric region is the most metabolically active and maximum loading occur at this site again explains our findings that subtrochanteric region is the commonest site for atypical femoral fracture.

Until recently there was lack of clear criteria and definition in diagnosing these unique atypical

Table III. — Criteria used for diagnosing an atypical fracture

Major Criteria	Minor Criteria
No history of trauma, or associated with low-energy trauma	Localized periosteal thickening of the lateral cortex
Fracture located anywhere from distal to the lesser trochanter to proximal to the supracondylar area	Generalized thickening of the femoral cortices
Transverse or short oblique fracture configuration	Prodromal symptoms
Non-comminuted fracture	May be associated with bilateral fractures or symptoms
Medial spike in complete fractures; incomplete fractures involve only the lateral cortex	Evidence of delayed fracture-healing
	Comorbid conditions or the use of some medications

fractures. Recently the American society for Bone and Mineral Research has described some major and minor features for the atypical femoral fractures (*19*) ; all of the major criteria should be present to diagnose atypical femoral fractures from other common fractures. All our 21 fractures fulfilled the major criteria.

All patients with atypical fractures in our study were warned of the risk of sustaining a contralateral side fracture but there were no such fractures in this series of patients. Bisphosphonates treatment was discontinued for all patients. Almost half of our patients were on bisphosphonates for more than six years. Bisphosphonates accumulate in the bone and continued to be released for many months even after stopping them (*22*). It has been recommended that patients with prolonged bisphosphonates for more than five years should be carefully assessed for the risk of osteoporotic fractures. If they do not have high risks for osteoporotic fractures it is recommended to stop the bisphosphonates (drug holiday) (*21*). If they have risk factors for fragility fractures then they can be given alternatives such as teriparatide or denosumab. The Flex study has shown that the stopping bisphosphonates after five years of treatment was not associated with increase in the incidence of osteoporotic fractures (*2*).

In conclusion we have demonstrated the presenting characteristics of a series of patients with atypical femoral fractures. The patients were from a younger age group that those with a typical proximal femur fracture. Prolonged bisphosphonate use, smoking and long term steroid use appeared to be associated in the aetiology of the fracture. Treatment with an internal fixation with an intramedullary nail resulted in high fracture union rates.

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