Prevalence of Atypical Femoral Fractures in Thai Patients at a Single Institution

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Objective: *Evaluate the prevalence of atypical femoral fracture (AFF) in Thai patients at a single institution based on the 2010 and 2013 American Society of Bone and Mineral Research (ASBMR) criteria and the sensitivity and specificity of each radiographic feature of AFF to identify bisphosphonate treatment.*

Material and Method: *The authors retrospectively reviewed plain radiographs of 856 patients who were diagnosed with subtrochanteric or femoral shaft fractures between 2002 and 2013. Only those who had major radiographic features of AFF according to the 2010 ASBMR criteria were included. Next, the prevalence of atypical fracture was recalculated based on the revised 2013 ASBMR criteria. Furthermore, the specificity and sensitivity of each radiological finding to detect bisphosphonate treatment were calculated.*

Results: *The prevalence of atypical femoral fracture based on 2010 ASBMR criteria at this institution was 5.7%. Two patients had all radiographic features of AFF but sustained a high-energy trauma and could be diagnosed with AFF based on the 2013 ASBMR criteria. Among all of the radiographic features to define AFF, a localized periosteal thickening of the lateral femoral cortex was the most specific sign to detect bisphosphonate treatment (0.98; 95% CI 0.96-0.99).*

Conclusion: *The prevalence of AFF in Thai patients at a single institution was approximately 6%. Although the prevalence of AFF did not dramatically change after applying the 2013 revised ASBMR criteria, this reflected some gap in the diagnosis criteria, which should require further refinement. The authors suggested that the ASBMR criteria should be used only with those having acute fractures.*

Keywords: *Atypical femoral fracture (AFF), Subtrochanteric fracture, Femoral shaft fracture, Bisphosphonate, American Society of Bone and Mineral Research, ASBMR*

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Bisphosphonates is the mainstay treatment for osteoporosis in both women and men, which acts by inhibiting function of the osteoclasts and inducing osteoclast apoptosis[1]. However, there is a substantial concern regarding severe suppression of the bone remodeling process from its long-term use, leading to a so-called condition "atypical femoral fracture"[2]. Although the pathogenesis remains controversial, evidence suggests that these relatively rare fractures are associated with prolonged bisphosphonate therapy with estimates of the odds ratio ranging from 2.3 to 139.3[3,4]. A mechanistic cause-and-effect relationship between bisphosphonate use and atypical femoral fracture, however, has not been established.

In 2010, the American Society of Bone and Mineral Research (ASBMR) initially described a classification system defining major and minor features of atypical femoral fractures, which included major criteria (low-energy trauma, transverse or short oblique configuration, non-comminuted fracture, and medial cortical beaking) and minor criteria (localized periosteal reaction, generalized cortical thickening, sign of delayed healing, prodromal symptoms and bilateral fractures)[5]. This case definition was further revised by the task force members and published as a new case definition in 2013[6]. Although atypical femoral fractures have been associated with Asian descent, with a prevalence of 32.6 to 50% of Asian population among those who were diagnosed with atypical femoral fractures[7,8], the prevalence of these fractures in Thai patients has not been reported.

The objectives of the present study were to 1) demonstrate the prevalence of atypical femoral fracture in Thai patients at a single institution based on the 2010 ASBMR criteria; 2) evaluate the sensitivity and specificity of different components of the radiographic ASBMR criteria to identify bisphosphonate treatment, and 3) evaluate the differences in atypical

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femoral fracture prevalence after applying 2013 ASBMR revised criteria for diagnosing atypical femoral fracture.

Material and Method

Following an Institutional Review Board approval, the authors retrospectively reviewed plain radiographs of 856 patients who were diagnosed with subtrochanteric/femoral shaft fractures between January 2002 and October 2013 at Siriraj Hospital, Bangkok, Thailand. Patients with inadequate radiographs, aged less than 20 years, associated with intertrochanteric or femoral neck fractures, multiple injuries, pathological or periprosthetic fractures were excluded. From 856 cases, only 435 patients met the inclusion and exclusion criteria and were included into the present study. The location of fractures was divided into subtrochanter (within 2.5 cm of the lesser trochanter) and femoral shaft (distal to subtrochanter to just proximal to the supracondylar flare). All radiographs were reviewed by one investigator (SL) and then confirmed with the senior author (AU). From 435 cases, only those who had major radiographic features of atypical femoral fracture according to the 2010 ASBMR criteria were included (Fig. 1). The patient was included and designated as a case only when both investigators agreed that the radiographs showed an atypical femoral fracture pattern. Both investigators were blinded to the patients' information including history of bisphosphonate exposure at the time of radiographs review. The electronic medical record and digital radiographs were obtained from the institution's computer database (Synapse® Workstation Software Version 3.2.1).

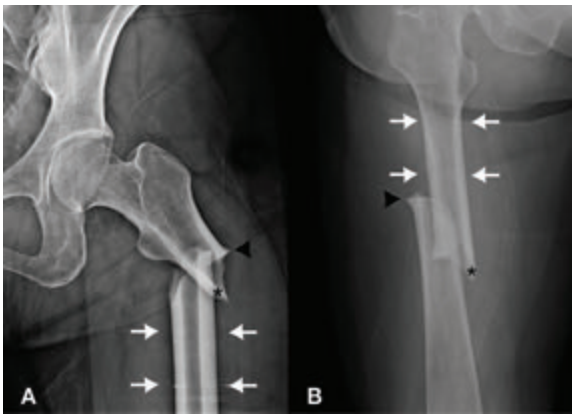

Fig. 1 Radiographs of patients diagnosed with atypical femoral fractures. The radiographic features of an atypical femoral fracture are shown including transverse or short oblique fracture configurations, non-comminution, medial cortical spike (asterisks), localized periosteal thickening of the lateral femoral cortex (black arrowheads), and generalized cortical thickening (white arrows).

Patients who had radiographic features of atypical fractures were then divided into two groups based on mechanism of injury: low-energy and high-energy trauma. Low-energy trauma was defined as fall from a standing height or less. Based on the 2010 ASBMR criteria, the diagnosis of atypical femoral fracture was made only in patients who sustained low-energy injury. Baseline demographic and clinical data were collected. These included age, sex, height, weight, body mass index, comorbid conditions, history of bisphosphonates exposure (ever or never), and duration of bisphosphonate use. Charlson comorbidity index was used to evaluate the comorbidity status of the patient and categorized into three levels: a score of 0 = low, a score of 1 to 2 points = medium, and a score of 3 points or more = high[9]. The duration of bisphosphonate used was calculated from the time since the first prescription order to the last order shown in the chart records.

Next, all 435 fractures were reclassified according to the new 2013 ASBMR criteria. Fractures were classified as atypical when at least four out of five major features were presented. These five major features were fracture associated with no- or minimal trauma, transverse or short oblique fracture line starting from the lateral cortex, association with medial cortical spike, non- or minimal comminution, and localized periosteal thickening of the lateral cortex[6]. The prevalence of atypical fracture was recalculated based on this revised 2013 ASBMR criteria.

Statistical analyses

Data analyses were carried out by using the SPSS software, version 16.0. Descriptive statistics were presented as means and standard deviations (SD) or as frequencies and percentages for discrete variables. Comparative analyses were made to compare demographic and clinical variables between patients with 2010 ASBMR major radiographic features of atypical fracture who sustained low- and high-energy fractures. Categorical data were analyzed using Chi-square test. Independent samples t-test was used to compare continuous variables. Mann-Whitney and Kruskal-Wallis were used for non-parametric data when appropriate. The specificity and sensitivity for each radiological finding to detect bisphosphonate

treatment were calculated with 95% confidence intervals (CI). Sensitivity was calculated as follows: (history of bisphosphonate, positive radiographic finding)/(history of bisphosphonate, positive radiographic finding + history of bisphosphonate, negative radiographic finding). Specificity was calculated as follows: no history of bisphosphonate, negative radiographic finding/no history of bisphosphonate, positive radiographic finding + no history of bisphosphonate, negative radiographic finding[10].

Results

From 435 patients, 97 (22.3%) had the ASBMR major radiographic criteria of atypical femoral fracture. Of 97 patients, 25 (25.8%) occurred after sustaining a low-energy trauma. Thus, the prevalence of atypical femoral fracture based on the 2010 ASBMR criteria in Thai patients at this institution was 5.7% (Fig. 2). Seventy-two patients were diagnosed with subtrochanteric/femoral shaft fracture from a high-energy injury but had major radiographic features of atypical femoral fracture.

When compared to patients who had major radiographic features of atypical femoral fracture but sustained a high-energy trauma, those who sustained a low-energy injury were older, more females, associated with higher scores of Charlson comorbidity index, used more medications and were associated with higher rate of bisphosphonates use (p<0.01) (Table 1). In addition, atypical femoral fracture from low-energy injury was located more at the subtrochanteric area than those from high-energy trauma (56% and 8.3%

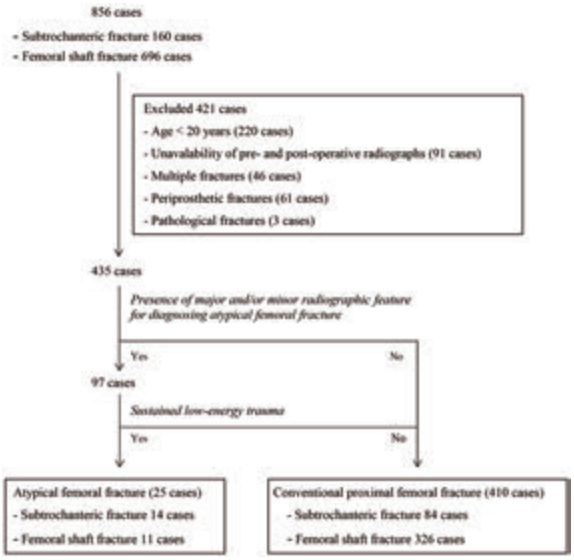

Fig. 2 Diagram showing the inclusion process of this study.

Table 1. The characteristic of patients with radiographic features of atypical femoral fracture who sustained low- and high-energy injuries

Variables	Low-energy trauma (n = 25)	High-energy trauma (n = 72)	p-value
Age*, years	68.3 (9.9)	30.6 (13.1)	<0.001
Gender, n (%)			<0.001
Male	8 (32%)	62 (86.1%)	
Female	17 (68%)	10 (13.9%)	
Body Mass Index*, kg/m^2	24.6 (4.1)	23.3 (4.5)	0.28
Fracture location			<0.001
Subtrochanter	14 (56%)	6 (8.3%)	
Femoral shaft	11 (44%)	66 (91.7%)	
Charlson comorbidity index, n (%)			<0.001
0	9 (36%)	65 (90.3%)	
1-2	9 (36%)	6 (8.3%)	
≥3	7 (28%)	1 (1.4%)	
Medications, n (%)			
Proton pump inhibitors	13 (52%)	15 (20.8%)	0.004
Statins	11 (44%)	4 (5.6%)	<0.001
Steroids	4 (16%)	0	0.004
Antihyperglycemic drugs	5 (20%)	1 (1.4%)	0.004
History of bisphosphonate use, n (%)	11 (44%)	1 (1.4%)	<0.001

* Data were presented as mean (standard deviation)

of patients with radiographic features of atypical fracture who sustained low- and high-energy injuries, respectively). Eleven patients (44%) with low-energy atypical femoral fracture had history of bisphosphonates use while only one patient (1.4%) in the high-energy atypical femoral fracture group used bisphosphonates. The proportions of patient who used bisphosphonates in low-energy atypical femoral fracture and ordinary subtrochanteric/femoral shaft fracture were 44% (11/25 cases) versus 0.24% (1/410 cases), respectively.

When evaluating the sensitivity and specificity of different components of the radiographic ASBMR criteria to identify bisphosphonate treatment, the authors found that medial cortical spike and non- or minimal comminuted fracture had the highest sensitivity of 93.3% (Table 2). Although localized periosteal reaction of the lateral cortex had the lowest sensitivity (73.0%), this feature had the highest specificity (97.9%) to detect bisphosphonate treatment. The specificity of transverse or short oblique fracture pattern to detect bisphosphonate treatment was only 56.2%, which is the lowest specificity of all features.

When applying the 2013 ASBMR criteria to redefine atypical femoral fracture, the authors found that two patients who sustained high-energy trauma could be added into the original group of low-energy atypical femoral fracture from the 2010 criteria. The first patient was a 61-year-old woman, diagnosed with osteopenia, who had taken ibandronate for four years. She had atypical subtrochanteric fracture of the right femur after falling from a 1.5-meter height chair (Fig. 3). The second patient that was included after applying the revised 2013 ASBMR criteria was a 56-year-old man who sustained a motorcycle accident about three months before presentation to our institution. He was able to walk on his affected leg with minimal pain. Plain radiograph was taken and showed a complete subtrochanteric fracture of left femur with some callus formation (Fig. 4). These two patients had all radiographic criteria of atypical femoral fracture: transverse or short oblique fracture pattern, non- or minimal comminution, presence of medial cortical spike and localized periosteal reaction of the lateral femoral cortex. Thus, the prevalence of atypical femoral fracture based on the revised 2013 ASBMR criteria increased from 5.7% to 6.2%.

Fig. 3 An anteroposterior radiograph of both hips showing atypical femoral fracture of right femur in a 61-year-old postmenopausal Thai woman after falling from a 1.5-meter height chair. There was also an ellipsoidal thickening in the left subtrochanteric region (arrow), compatible with a chronic stress reaction of the lateral femoral cortex.

Discussion

Atypical femoral fractures have been associated with various factors, including the use of glucocorticoids and proton pump inhibitors, bilateral fractures, presence of prodromal symptoms and Asian descent[11]. Previous studies reported a high incidence of Asian population who diagnosed with atypical femoral fracture with a prevalence of 32.6% to 50.0% from the total atypical femoral fracture cases[7,8]. It is possible that Asian people have a higher risk of developing atypical fracture because of their increased femoral bow, which is subjected to a greater tensile loading[12]. Thus, these patients are prone for stress fracture at the lateral femoral cortex, which is one of the proposed pathogeneses of atypical femoral fracture[11]. Here, the authors reported a prevalence of

Table 2. Sensitivities and specificities of each radiographic feature of atypical femoral fracture to detect bisphosphonate treatment

Radiographic findings	Sensitivity (95% CI)	Specificity (95% CI)
Transverse or short oblique fracture pattern	80.0% (51.4%-94.7%)	56.2% (51.3%-61.0%)
Medial cortical spike	93.3% (66.0%-99.7%)	65.0% (60.2%-69.5%)
Non- or minimal comminuted fracture	93.3% (66.0%-99.7%)	69.0% (64.3%-73.4%)
Localized periosteal reaction of the lateral cortex	73.0% (44.8%-91.1%)	97.9% (95.8%-99.0%)

Fig. 4 Radiograph of a 56-year-old Thai man with proximal femoral fracture after sustaining a motorcycle accident approximately 3 months prior to presentation at our institution. Plain radiograph of left hip showed evidence of atypical femoral fracture including short oblique fracture configuration, non-comminuted fracture, medial cortical spike and localized thickening of the lateral femoral cortex (arrow). There was also callus formation around the fracture site which corresponded to the chronicity of the fracture.

5.7% of atypical femoral fracture among Thai patients who presented with subtrochanteric/femoral shaft fracture at a single institution. The prevalence of atypical femoral fracture that has been reported specifically in Asian countries ranged from 0.8% to 35.1% (Table 3)[13-15]. The reasons for this large discrepancy are unclear. It is possible that each study used different definition, population sample, or duration of data collection and methods to identify atypical femoral fracture cases.

Although the pathogenesis of low-energy subtrochanteric/femoral shaft fracture is unknown, one common proposed mechanism to explain atypical femoral fracture is related to microdamage accumulation and impairment of stress fracture healing from long-term bisphosphonates treatment[11]. Since several clinical reports showed that a periosteal stress reaction and a transverse radiolucent line indicative of stress fracture usually preceded the complete atypical fracture in patients taking bisphosphonates, this indicates a possible role for bisphosphonates in

Table 3. Prevalence of atypical femoral fractures in Asian population

Author	Journal/year	Country	Duration of data collection	Population	Definition of atypical femoral fracture	Prevalence, n (%)
Leung et al[13]	BMJ Case Rep 2009	Hong Kong	5 years (2003-2008)	Subtrochanteric or femoral shaft fractures	Low-energy injury subtrochanteric or femoral shaft fractures with alendronate therapy	10/154 (6.5%)
Sasaki et al[14]	J Bone Miner Metab 2012	Japan	5 years (2005-2010)	Femoral shaft fracture	Simple transverse fracture with a medial spike configuration	12/34 (35.1%)
Lin et al[15]	BMC Research Notes 2013	China	7 years (2004-2011)	Subtrochanteric or femoral shaft fractures	2010 ASBMR criteria with alendronate therapy for >36 months	10/1,254 (0.8%)
The present study		Thailand	11 years (2002-2013)	Subtrochanteric or femoral shaft fractures	2010 ASBMR criteria	25/435 (5.7%)

ASBMR = American Society of Bone and Mineral Research

impaired stress-fracture healing[16-18]. Schilcher et al evaluated the specificity and sensitivity of different components of the radiographic ASBMR criteria to identify bisphosphonate treatment in 59 atypical and 218 ordinary fractures and found that presence of a callus reaction had the highest specificity (0.96; 95% CI of 0.92-0.98) to detect bisphosphonate use[10]. Rosenberg et al also analyzed sensitivity, specificity and accuracy of radiographic features in a case-control analysis of 38 radiographs with complete subtrochanteric and femoral shaft fractures in two patient groups, one group being treated with bisphosphonates (19 fractures in 17 patients) and another group not being treated with bisphosphonates (19 fractures in 19 patients). The authors found that focal lateral cortical thickening and transverse fracture pattern were the most accurate factors for detecting bisphosphonate-related fractures with odds ratios of 76.4 and 10.1 for focal lateral thickening and transverse fracture, respectively[19]. Similar to their findings, the authors showed that localized periosteal reaction of the lateral femoral cortex had a highest specificity (97.9%) for diagnosing bisphosphonate-related atypical femoral fracture. Interestingly, the sensitivity of this radiographic feature is only moderate (73%) which means that many patients using bisphosphonates still may have an ordinary osteoporosis fracture.

In 2013, ASBMR revised the original 2010 criteria for diagnosing atypical femoral fracture and stated that at least four of the five major features must be presented. Low-energy fracture is no longer required to be an essential element when diagnosing atypical femoral fracture. Thus, the authors could add 2 more patients who sustained a high-energy trauma but had radiographic features of atypical fracture into the atypical femoral fracture group. The first patient was a 61-year-old postmenopausal woman who took bisphosphonates for four years. Her radiograph showed a complete atypical femoral fracture on one side and an incomplete fracture (stress lesion) on the contralateral side. Her fracture occurred after a fall from a 1.5-meter height chair, which by definition was not considered as a low-energy trauma. As for the second patient, he presented to our institution two months after a motorcycle accident. Interestingly, he was able to walk on his affected leg during those two months. Radiograph revealed a callus formation, which supported the chronicity of this fracture, not the acute fracture that just developed a few days prior to arrival to our hospital. Although his radiograph showed a localized periosteal thickening, the authors believed that this feature was a result of chronic fracture, not a stress fracture-induced atypical femoral fracture that was usually found in other patients. Thus, the authors suggest limiting using these criteria to those of acute fractures in order to increase the accuracy of the case definition to detect the true, pathologic, atypical femoral fracture.

The strength of the present study is that the authors confirmed the diagnosis of atypical femoral fracture through charts and radiographs review. This step is very crucial because by using ICD codes to identify cases may lead to overestimation of fractures due to codes that appear for old fractures; or, alternatively, fracture location could be miscoded. Feldstein et al demonstrated that of the 197 subtrochanteric femoral shaft fractures that were classified after reviewing radiographs, only 130 (66%) were correctly identified by ICD9 codes[4]. In addition, the codes cannot distinguish between an ordinary fracture and an atypical fracture. Therefore, review of radiographs enhances case ascertainment for confirming fracture location and atypical fracture status.

The present study has several limitations. Firstly, the authors reviewed radiographs in only one hospital in Thailand, which is a university-based hospital. Therefore, the sample population in the present study is relatively homogenous. It is possible that the prevalence of atypical femoral fracture of the whole country will be different than the number reported here. In addition, our data were limited by being retrospectively collected in the course of usual clinical care, as opposed to collection in a research setting, thus resulting in approximately half of cases did not have radiographs available. The proportion of subtrochanteric/femoral shaft fractures that were atypical may be underestimated. Furthermore, the authors did not evaluate the association between duration of treatment with bisphosphonates and the occurrence of atypical femoral fractures. Nevertheless, similar to many previous studies[20-22], our findings suggested that bisphosphonates were associated with atypical femoral fractures (the rates of bisphosphonates use were 44% and 0.24% for atypical and ordinary subtrochanteric/femoral shaft fractures, respectively). This confirms that the use of this medication is one of multiple associated factors.

In summary, the prevalence of atypical femoral fracture in Thai patients at a single institution was approximately 6%. Similar to other studies, bisphosphonates was strongly associated with this

type of fracture. Among all of the radiographic features to define atypical femoral fracture, a localized periosteal thickening of the lateral femoral cortex was the most specific sign to detect bisphosphonate treatment. In the present study, two patients had radiographic features of atypical femoral fracture but sustained a high-energy trauma. Although the prevalence of atypical femoral fracture does not dramatically change after applying the 2013 revised ASBMR criteria, this reflects some gap in the diagnosis criteria, which should require further refinement. The authors suggest that the ASBMR criteria should be used only with those having acute fractures.

What is already known on this topic?

Bisphosphonates are the most commonly prescribed drug for the treatment of osteoporosis. Treatment with bisphosphonates, however, is not without adverse effects. Many case reports and case series have shown an association between prolonged bisphosphonate use and a unique fracture configuration, so-called "atypical femoral fracture". In 2010, the American Society of Bone and Mineral Research (ASBMR) initially described a case definition of atypical femoral fracture, including major and minor features. This case definition was further revised by the task force members and published a new case definition in 2013.

Although the pathogenesis of this atypical femoral fracture remains unknown, it has been shown to be associated with many factors, including the use of glucocorticoids and proton pump inhibitors, bilateral fractures, presence of prodromal symptoms and Asian descent. Data of several large registries from the western countries showed a high proportion of Asian population, with a prevalence of 32.6 to 50% of Asians among those who diagnosed with atypical femoral fractures. Studies that reported the prevalence of atypical femoral fracture specifically in Asian countries showed the prevalence of atypical femoral fracture ranged from 0.8 to 35.1%.

What this study adds?

The prevalence of atypical femoral fracture in Thai patient at a single institution was approximately 6%. The present study is the first study to evaluate the prevalence of atypical femoral fracture after applying both the 2010 and 2013 ASBMR criteria. Although the prevalence of atypical femoral fracture does not dramatically change after applying the 2013 revised ASBMR criteria, it reflects some gap in the diagnosis criteria, which should require further refinement. In addition, the present study showed that among all of the radiographic features to define atypical femoral fracture, a localized periosteal thickening of the lateral femoral cortex was the most specific sign helping to detect bisphosphonate treatment.

Potential conflicts of interest

None.

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การศึกษาความชุกของกระดูกต้นขาหักแบบไม่ปกติในผู้ป่วยไทยของโรงพยาบาลศิริราช

สิทธิชัย เหลืองกิตติก้อง, อาศิส อุนนะนันทน์

วัตถุประสงค์: ศึกษาความชุกของกระดูกต้นขาหักแบบไม่ปกติในผู้ป่วยไทยของโรงพยาบาลศิริราช โดยใช้เกณฑ์การวินิจฉัยของ American Society of Bone and Mineral Research (ASBMR) ปี พ.ศ. 2553 และ พ.ศ. 2556 และศึกษาความไวและความจำเพาะของลักษณะภาพถ่ายรังสีของกระดูกต้นขาหักแบบไม่ปกติแต่ละแบบที่บ่งชี้ถึงการใช้ยากลุ่ม bisphosphonate

วัสดุและวิธีการ: การศึกษาเชิงพรรณนาโดยการเก็บรวบรวมข้อมูลแบบย้อนหลังโดยการพิจารณาภาพถ่ายรังสีบริเวณกระดูกต้นขาในผู้ป่วย 856 ราย ที่ได้รับการวินิจฉัยโรคกระดูกต้นขาหักบริเวณ subtrochanter หรือ femoral shaft ตั้งแต่ปี พ.ศ. 2545 ถึง พ.ศ. 2556 คัดเลือกผู้ป่วยที่มีภาพถ่ายรังสีเข้าได้กับกระดูกต้นขาหักแบบไม่ปกติ ตามเกณฑ์การวินิจฉัยของ ASBMR ปี พ.ศ. 2553 และทำการคำนวณความชุกของกระดูกต้นขาหักแบบไม่ปกติในผู้ป่วยกลุ่มนี้อีกครั้ง โดยใช้เกณฑ์การวินิจฉัยของ ASBMR ปี พ.ศ. 2556 และคำนวณหาความไวและความจำเพาะของลักษณะภาพถ่ายรังสีของกระดูกต้นขาหักแบบไม่ปกติแต่ละแบบที่บ่งชี้ถึงการใช้ยากลุ่ม bisphosphonate

ผลการศึกษา: ความชุกของกระดูกต้นขาหักแบบไม่ปกติในผู้ป่วยไทยของโรงพยาบาลศิริราช โดยใช้เกณฑ์การวินิจฉัยของ ASBMR ปี พ.ศ. 2553 เท่ากับ 5.7 เปอร์เซ็นต์ เมื่อพิจารณาโดยใช้โดยใช้เกณฑ์การวินิจฉัยของ ASBMR ปี พ.ศ. 2556 พบว่ามีผู้ป่วย 2 ราย ที่มีภาพถ่ายรังสีที่เข้าได้กับกระดูกต้นขาหักแบบไม่ปกติซึ่งได้รับการบาดเจ็บจากภยันตรายแบบรุนแรง ในส่วนของลักษณะภาพถ่ายรังสีของกระดูกต้นขาหักแบบไม่ปกติแต่ละแบบ พบว่าการหนาตัวเฉพาะที่บริเวณกระดูกส่วน cortex ด้านนอกมีความความจำเพาะสูงสุดในการบ่งชี้ถึงการใช้ยากลุ่ม bisphosphonate (0.98; 95% CI 0.96-0.99)

สรุป: ความชุกของกระดูกต้นขาหักแบบไม่ปกติในผู้ป่วยไทยของโรงพยาบาลศิริราชอยู่ที่ประมาณ 6 เปอร์เซ็นต์ ถึงแม้ว่าการประเมินซ้ำโดยใช้เกณฑ์การวินิจฉัยของ ASBMR ปี พ.ศ. 2556 จะพบว่าค่าความชุกของกระดูกต้นขาหักแบบไม่ปกติในผู้ป่วยไทยจะยังคงไม่แตกต่างจากเดิมอย่างชัดเจน แต่ความแตกต่างของค่าความชุกนี้สะท้อนให้เห็นถึงช่องโหว่ของเกณฑ์การวินิจฉัยโรคกระดูกต้นขาหักแบบไม่ปกตินี้ ซึ่งควรได้รับการปรับปรุงต่อไป คณะผู้นิพนธ์แนะนำว่าเกณฑ์การวินิจฉัยของ ASBMR ควรใช้เฉพาะในผู้ป่วยกระดูกหักเฉียบพลัน