High Prevalence of Asymptomatic Vertebral Fractures in Chinese Women with Systemic Lupus Erythematosus

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ABSTRACT. ***Objective.*** To investigate the prevalence of vertebral fractures and to identify risk factors associated with vertebral fractures in Chinese women with systemic lupus erythematosus (SLE).

Methods. One hundred fifty-two consecutive patients with SLE were recruited in this cross-sectional study. Bone mineral density (BMD) measurements of the hip and spine were performed using the same dual energy X-ray absorptiometry (DEXA). Lateral radiographs of the spine (T5–L4) were assessed for vertebral fractures using a method described by Genant. Inflammatory and biochemical markers included C-reactive protein, receptor activator of nuclear factor-κB ligand, serum ß-CrossLaps assay for C-terminal telopeptides of type 1 collagen, and osteoprotegerin (OPG).

Results. Asymptomatic vertebral fractures occurred in 20.4% of patients with SLE. Univariate analyses of variables associated with fractures were older age, higher body mass index (BMI), lower BMD spine, lower BMD hips, higher serum C3 and C4, longer estrogen exposure, higher levels of OPG, and the use of sunscreen. Multivariate analysis showed older age ($p = 0.017$), higher BMI ($p < 0.036$), and lower BMD of the spine were significantly associated with vertebral fractures in the thoracic and/or lumbar spine (odds ratio 1.068, 1.166, 0.005; $p = 0.018$, $p = 0.025$, $p = 0.003$, respectively).

Conclusion. Asymptomatic vertebral fractures occur in 20.4% of patients with SLE and 30% of these patients have normal BMD. The current method using DEXA to predict the presence of vertebral fracture has limited value and there is a need for assessment of bone quality. Vertebral morphometry in patients with SLE is recommended and early therapeutic intervention is necessary to prevent vertebral fractures in patients with SLE. (J Rheumatol First Release July 15 2009; doi:10.3899/jrheum.081337)

Key Indexing Terms:
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Despite improved longterm survival[1], patients with systemic lupus erythematosus (SLE) continue to have substantial morbidity associated with the disease itself or its therapy. Patients with SLE have a higher risk of symptomatic vertebral and nonvertebral fractures of between 9% and 16.5%[2-6], and vertebral deformities as a result of fractures[7-13]. Patients with vertebral fractures have been shown to have increased mortality rates, risk of vertebral and nonvertebral fractures during the following decade[14], and reduced quality of life[15].

Risk factors for fractures in patients with SLE include the duration of use of corticosteroids[4,16,17], ever use of intravenous (IV) methylprednisolone[4,5,18], and male sex[18], but vertebral fractures can occur in patients who are not osteoporotic[18] and with normal bone mineral density (BMD)[19]. These suggest other risk factors such as bone quality, including microarchitecture, bone remodeling, bone turnover, and mineralization, or the role of inflammation in SLE, the extent of which has not been thoroughly studied.

Recently, bone turnover markers (formation and resorption) have been shown to be helpful in predicting the rate of postmenopausal bone loss[20] and in assessing risks for bone fracture[21,22]. Osteoprotegerin (OPG), a product of cells of

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the osteoblastic lineage, was shown to be independently associated with osteoporosis and prevalent vertebral fractures in postmenopausal women[23]. OPG binds and neutralizes the receptor activator of nuclear factor-κB ligand (RANKL) on the surface of pre-osteoclasts that mediate the effects of several stimulators of osteoclastogenesis. Another new marker for bone resorption, ß-CrossLaps assay for C-terminal telopeptides of type I collagen (ß-CTX), was shown to be a good predictor for bone loss in patients with metabolic bone diseases[24]. Whether these bone turnover markers are helpful in assessing the risk of fracture in steroid-induced osteoporosis has never been studied. In an effort to elucidate other nontraditional osteoporotic risk factors for fracture, we have included RANKL, OPG, and ß-CTX as part of our laboratory assessments.

The primary aim of our study was to investigate the prevalence of vertebral fractures, as determined by a standardized assessment, and the secondary aim was to identify risk factors associated with prevalent vertebral fractures in a large population of Chinese women with SLE.

MATERIALS AND METHODS

Patients. One hundred fifty-two consecutive Chinese women with a diagnosis of SLE were included in our study. All patients regularly attended the outpatient rheumatology clinic at Prince of Wales Hospital in Hong Kong. All patients fulfilled the American College of Rheumatology (ACR) revised criteria for the classification of SLE[25]. The study was approved by the local ethics committee and written informed consent was obtained from all patients.

Data collection and clinical measures. Demographic and clinical characteristics were recorded by interview, self-reported questionnaires, chart review, and clinical examinations. Data collected at the time of study inclusion were age, disease duration, race, menstrual status, age at menopause, periods of amenorrhea, family history of osteoporosis, ultraviolet light intolerance, sunshine avoidance, use of sunscreens in the previous year, calculated mean daily dietary calcium intake in the last 3 months, history of (non)vertebral fractures after the age of 25 years, comorbidity, alcohol and tobacco intake, and exercise status. Exercise was determined as the weekly frequency of a minimum of 40 min of aerobic exercise performed. Also included is history of corticosteroid use, including intravenous (IV) methylprednisolone use (past and current) and oral corticosteroid use (past use, duration of use in months, maximum dosage ever taken, current use, and current dosage). The cumulative corticosteroid dose was calculated by chart review. Past and current use of antirheumatic drugs, calcium supplements, vitamin D supplements, multivitamin supplements, hormone-replacement therapy, oral contraceptives, anti-osteoporosis medications, antiepileptic agents, and anticoagulants was also documented.

Body weight, height, and body mass index (BMI) were assessed. Disease activity was scored using the SLE Disease Activity Index (SLEDAI)[26]. Accumulated organ damage was assessed with the Systemic Lupus International Collaborating Clinics (SLICC)/ACR damage index[27]. Laboratory investigations included routine clinical biochemistry profile: complete blood count, liver and renal function tests, immunologic measures such as anti-double-stranded DNA antibodies, serum complement 3 and 4, antiphospholipid antibodies, and biochemical and hormonal variables related to mineral metabolism including serum levels of calcium, vitamin D, phosphate, alkaline phosphatase, thyroid-stimulating hormone levels, and serum levels of 25-hydroxyvitamin D (25(OH)D) which were measured by radioimmunoassay (DiaSorin Inc., Stillwater, MN, USA). The reference range used in our hospital to indicate deficiency was serum level < 10 μg/l. Inflammatory markers measured included C-reactive protein (CRP). Biochemical markers of bone turnover included OPG measured by ELISA (Immunodiagnostik AG) RANKL measured by ELISA (Immunodiagnostik AG, Bensheim, Germany), and ß-CTX measured by electrochemiluminescence immunoassay on the Roche Elecsys 2010 analyser (Roche Diagnostics Corp., Indianapolis, IN, USA).

BMD measurements. BMD measurements of the hip (total hip and femoral neck) and the lumbar spine (L1–L4; anteroposterior view) were performed by a trained technician using the same dual-energy X-ray absorptiometry (DEXA) equipment (model 4500A; Hologic, Bedford, MA, USA) in all patients, and the results were expressed in g/cm^2. The BMD values of both lumbar and hip were compared to the BMD reference norms of the Chinese population in Hong Kong[28].

Assessment of vertebral deformities. Lateral radiographs of the thoracic and lumbar spine (T5–L4) were performed in the same radiology department by a trained operator according to a standardized protocol. All radiographs were of good quality, with good visibility and reliable identification of all vertebrae. Spinal radiographs were evaluated by a single experienced musculoskeletal radiologist with over 20 years' experience in reporting spine radiographs. Intra- or interobserver agreement was not assessed in this study, as we used an established semiquantitative method to define and grade vertebral fracture described by Genant, *et al*[29]. This straightforward analysis method has been used by several similar studies, with a kappa ranging from 0.78 to 0.89. This method grades vertebrae on a scale of 0–3, where grade 0 = normal, grade 1 = 20%–25% reduction in height, grade 2 = 25% but ≥ 40% reduction in height, and grade 3 = > 40% reduction in height. For the anterior and middle heights, the posterior height of the same vertebra was used as a reference. A vertebral fracture was defined as a reduction of at least 20% of the vertebral body height.

Statistical analysis. Statistical analyses were performed using the Statistics Package for Social Sciences (SPSS for Windows, version 13.0, 2006; SPSS Inc., Chicago, IL, USA). Results are expressed as mean ± standard deviation (SD) for normally distributed data. For non-normally distributed data, median and interquartile range are expressed. Variables possibly associated with the presence of vertebral fractures were examined first by univariate tests and subsequently by multiple regression analysis. Continuous variables were compared by the independent samples t-test (with normal distribution) or Mann-Whitney U-test (with non-normal distribution). Categorical variables were compared by chi-squared test. The following variables were examined in relationship to vertebral fractures by univariate analyses: age, body height, body weight, BMI, menopause status, average dietary calcium intake, disease duration, BMD of the lumbar spine and hip, disease activity, use of sunscreens, age at menopause, previous nonvertebral fractures, 25(OH)D deficiency, levels of vitamin D, estrogen exposure in years, ever use of corticosteroids, methylprednisolone, duration of corticosteroid use, cumulative doses of corticosteroid, average daily dose of prednisolone, current use of corticosteroids, and past and current use of hormone replacement therapy, hydroxychloroquine, and immunosuppressants including azathioprine, cyclosporine A, mycophenolate mofetil, and cyclophosphamide. To determine which factors were significantly associated with vertebral fractures, the demographic, clinical, and treatment variables showing $p < 0.1$ in the univariate analyses were entered into the multiple regression analysis. A p value ≤ 0.05 (2-sided) was considered statistically significant in the multiple regression analysis.

RESULTS

Clinical, demographic, and treatment variables. The clinical and demographic features of the 152 patients with SLE are shown in Table 1, and treatment profile is summarized in Table 2. Vitamin D deficiency was detected in 4.6% of patients. Ever-smokers made up 8.5% and ever-drinkers 22.4%. Seventy-three percent of patients avoided sun expo-

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Table 1. Demographic and clinical variables of the patients.

Variables	All Patients (n = 152)
Demographic variables	
Age, mean ± SD, yrs	47.9 ± 10.5
Body height, mean ± SD, cm	155.8 ± 5.8
Body weight, mean ± SD, kg	54.4 ± 9.2
Body mass index, mean ± SD, kg/m^2	22.4 ± 3.5
Estrogen exposure, mean ± SD, yrs	28.7 ± 7.3
Menopausal, %	68.4
Age of menopause, median (IQR), yrs	45.0 (41.0–49.0)
Duration of menopause, median (IQR), yrs	6.3 (2.5–10.5)
Loading exercise median (IQR), h/wk	0.0 (0–0.5)
Daily dietary calcium intake, mean ± SD, mg	258.5 ± 103.0
Clinical variables	
Disease duration, median (IQR), yrs	10.4 (5.6–17.3)
SLEDAI, mean ± SD	1.8 ± 0.2
SLICC*, median (IQR)	1.0 (0.1)
CRP, median (IQR), mg/l	1.0 (1.0–2.8)
Creatinine clearance < 50 ml/min, %	6.6
Ever had lupus nephritis, %	64.2

SLEDAI: Systemic Lupus Erythematosus Disease Activity Index (range 0–105); SLICC/ACR: Systemic Lupus International Collaborating Clinics/American College of Rheumatology (*modified damage index excluding osteoporotic fractures as a damage item); IQR: interquartile range; CRP: C-reactive protein.

Table 2. Treatment received by the patients.

Treatment Variables	All Patients (n = 152)
Oral corticosteroids	
Ever use, %	91.4
Current use, %	71.7
Duration, median (IQR), yrs	10.0 (4.1–15.6)
Daily prednisolone dose, median (IQR), mg	6.4 (4.7–8.4)
Current prednisolone dose, median (IQR), mg	5 (5.5)
Highest dose, median (IQR), mg	40 (30.60)
IV corticosteroids	
Ever use IV methylprednisolone, %	30.3
Current user of IV methylprednisolone, %	0
Ever use of immunosuppressants, %	
Hydroxychloroquine	66.2
Azathioprine	52.3
Cyclophosphamide	26.7
Mycophenolate mofetil	2
Methotrexate	1.3
Leflunomide	3.3
Cyclosporine A	17.3
Ever use of other medications, %	
Bisphosphonates	0.7
Calcitonin	3.3
Hormone replacement	3.3
Calcium supplement	45.6
Vitamin D	27.9
Anticonvulsant	3.9
Angiotensin-converting enzyme	30.9
Thiazides	1.3

IQR: interquartile range; IV: intravenous.

sure, with 62.5% of patients having ever used sunscreen. A history of nonvertebral fracture and family history of fractures were present in 10.5% and 14.6%, respectively.

BMD measurements. The results of the BMD and the assessment of vertebral deformities are shown in Table 3. The frequency of osteoporosis (T scores < –2.5 SD at the lumbar spine and/or at the total hip) was 21.7%. The frequency of osteopenia (T scores < –1.0 SD at the lumbar spine and/or at the total hip) was 59.9%.

Vertebral deformities. Lateral spinal radiographs were reviewed in 152 patients. Results of the assessment of vertebral deformities are shown in Table 3. One patient had coexisting thoracic and lumbar deformities and none had more than 1 fracture in the lumbar spine. Four patients had 2 thoracic deformities, 3 had 3 thoracic deformities, and 1 patient each had 4, 5 and 6 thoracic deformities, respectively.

Out of 31 patients with fractures, 9 vertebral deformities (29.0%) occurred in patients with normal BMD, 7 of which were thoracic and 2 lumbar deformities; 8 thoracic vertebral deformities (25.8%) occurred in patients with osteopenic spine, while 14 vertebral deformities (45.2%), occurred in patients with osteoporotic spine. The occurrence of a vertebral deformity in the thoracic spine with normal BMD was 25%, in osteopenic spine 28.6%, and in osteoporotic spine 46.4%. When the BMD is compared between those who have a single vertebral deformity with patients having 2 or more vertebral deformities, a trend towards a lower BMD of

Table 3. BMD variables and assessment of vertebral deformities.

Variables	All Study Patients, n = 152
BMD, mean ± SD g/cm^2	
Spine L1-L4	0.86 ± 0.15
Total hip	0.79 ± 0.12
T score, mean ± SD	
Spine	–1.2 ± 1.4
Total hip	–0.86 ± 1.2
Osteopenia, %	
Lumbar spine and/or total hip	59.9
Lumbar spine	40.8
Total hip	39.5
Osteoporosis, %	
Lumbar spine and/or total hip	21.7
Lumbar spine	18.4
Total hip	9.4
Number of patients with the following deformities	
1 vertebral deformity, n (%)	21 (14.6)
≥ 1 vertebral deformities, n (%)	31 (20.4)
≥ 2 vertebral deformities, n (%)	10 (6.6)
Thoracic vertebral deformities, n (%)	28 (18.4)
Lumbar vertebral deformities, n (%)	4 (2.6)
Grade 1 (20–25% reduction of height)	24 (15.9)
Grade 2 (25-40% reduction of height)	7 (4.7)
Grade 3 (> 40% reduction of height)	5 (3.3)

BMD: bone mineral density.

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the spine, but not the hip, is seen (0.73 ± 0.23 g/cm^2 and 0.76 ± 0.15 g/cm^2; p < 0.07).

Variables associated with vertebral deformities

Univariate analyses. There was significant association among older age (p = 0.000), higher BMI (p = 0.036), lower BMD of spine (p = 0.002), lower BMD of the hips (p = 0.003), higher C3 (p = 0.023) and C4 (p = 0.001), longer estrogen exposure (p = 0.019), higher levels of serum OPG (p = 0.029), the use of sunscreen (p = 0.049), and vertebral fracture in the thoracic and/or lumbar spine (Table 4). There were no differences in vitamin D levels between patients with and without fractures. There were 43 patients taking vitamin D supplements. Of the 109 patients who were not vitamin D users, serum vitamin D level did not differ between patients with and without vertebral fractures (p = 0.183). Similarly, there was no correlation between BMD and serum vitamin D level in those who were not taking vitamin D supplements (BMD of L1-L4: r = –0.037, p = 0.704; BMD of hip, r = 0.060, p = 0.537).

Inflammatory markers (CRP) and biochemical markers of bone turnover (ß-CTX and RANKL) were not associated

Table 4. Univariate analyses of explanatory variables associated with fracture.

Variables	Patients with Fractures, n = 31	Patients without Fractures, n = 121	p
Demographic variables			
Age, yrs	55.0 ± 9.97	46.0 ± 9.9	< 0.0005
Smoking, n (%)	2 (6)	11 (9)	NS
Body weight, kg	55.8 ± 10.1	54.1 ± 8.9	NS
BMI, kg/m^2	23.8 ± 4.2	22.0 ± 3.3	0.036
Bone profile			
BMD hip, g/cm^2	0.74 ± 0.14	0.81 ± 0.12	0.003
BMD L1–L4, g/cm^2	0.76 ± 0.19	0.88 ± 0.13	0.002
Vitamin D levels, µg/l	24.3 ± 11.7	19.9 ± 7.2	0.053
Calcium intake, mg/day	262.0 ± 119.9	258.2 ± 99.03	NS
Past fractures, n (%)	5 (16)	11 (9)	NS
Serum OPG, pmol/l*	5.55 (4.22, 7.53)	4.75 (3.79, 5.93)	0.029
Serum RANKL level, pmol/l*	220.0 (29–1115.7)	422.1 (83.6–1557.4)	NS
Serum ß-CTX, nmol/l, µg/l*	0.25 (0.12–0.52)	0.19 (0.04–0.34)	NS
Use sunscreen	15/95 (15.8)	80/120 (66.6)	0.049
Clinical variables			
Disease duration	14.0 ± 8.1	11.3 ± 7.1	NS
SLEDAI	1.6 ± 2.1	1.9 ± 2.1	NS
SLICC-Modified†	1 (0, 2)	0 (0, 1)	0.051
Serum C3	1.01 ± 0.19	0.90 ± 0.25	0.023
Serum C4	0.30 ± 0.13	0.21 ± 0.09	0.000
Estrogen exposure, yrs	31.5 ± 5.7	28.0 ± 7.5	0.019
Premenopausal, n (%)	5 (16)	43 (36)	0.036
Age at menopause*	43 (38, 50)	40 (0, 46)	NS
Medications			
Duration of steroid, yrs*	10.8 (4.34, 19.72)	9.2 (4.06, 14.54)	NS
Current dose of prednisolone, mg/day*	5.0 (3.1, 8.4)	6.4 (4.8, 8.2)	NS
Highest dose of prednisolone, mg/day*	40 (20, 60)	40 (25, 54)	NS
Cumulative dose of steroid, mg	24,094.6 ± 22,615	22,040.4 ± 18,164	NS
Methylprednisolone IV, n (%)	12 (39)	33 (27)	NS
Hydroxychloroquine, n (%)	23 (74.2)	76 (63.9)	NS
Cyclophosphamide IV, n (%)	9 (29)	30 (25.4)	NS
Oral cyclophosphamide, n (%)	10 (32.3)	26 (22.0)	NS
Cyclosporine A, n (%)	4 (12.9)	22 (18.6)	NS
Mycophenolate mofetil, n (%)	1 (3.2)	2 (1.7)	NS
Immunoglobulin IV, n (%)	4 (12.9)	8 (6.8)	NS
Hormone replacement therapy, n (%)	4 (12.9)	14 (11.9)	NS

* Values are median (interquartile range), otherwise mean ± standard deviation. NS: not significant; BMI: body mass index; OPG: osteoprotegerin; BMD: bone mineral density; RANKL: receptor activator of nuclear factor-κB ligand; ß-CTX: ß-CrossLaps assay for C-terminal telopeptides of type I collagen; SLEDAI: Systemic Lupus Erythematosus Disease Activity Index (range 0–105); SLICC/ACR: Systemic Lupus International Collaborating Clinics/American College of Rheumatology (†modified damage index excluding osteoporotic fractures as a damage item).

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with vertebral fractures. Other variables not associated with fractures included vitamin D levels, daily calcium intake, and duration of corticosteroid intake, cumulative dose and current dose of corticosteroid intake, amount of loading exercises, smoking, history of fractures, and various drugs.

Multivariate analyses. The possible explanatory variables including age, BMI, BMD of the spine and hip, vitamin D levels, duration of estrogen exposure, the use of sunscreen, C3, C4, and modified SLICC were analyzed in a multivariate analysis. Independent explanatory variables associated with vertebral fractures were older age ($p < 0.017$), higher BMI ($p < 0.036$), and lower BMD of the spine ($p < 0.005$) (Table 5).

DISCUSSION

This is the largest study with a Chinese female population that examined the prevalence of asymptomatic vertebral deformities in patients with SLE, using a standardized semiquantitative method of scoring vertebral deformities. The main conclusion from our study is a high prevalence of asymptomatic vertebral fractures (20.4%) in patients with SLE, which is consistent with 2 other studies[18,19], and that one-third of those with fractures had normal BMD. Previous reports revealed the fracture risk among patients with SLE was 5-fold higher than that of the general population of northern Chinese 50 to 59 years old [3.9%; 95% confidence interval (CI) 1%-9%][30]. A recent report has also shown that fractures occurred 5 times more frequently than expected in women with SLE and the risk was highest in young women. Almost 50% of the fractures occurred in women with SLE who were under the age of 50 years or before menopause[4]. These data emphasize a need to recognize this potentially preventable condition.

A trend towards lower BMD seen in patients having 2 or more vertebral deformities than in those with a single vertebral deformity is also consistent with the previous findings[19]. Despite our patients being older than those from the 2 previous studies (20 and 8 years older, respectively)[18,19], the prevalence of vertebral fracture was similar. Although direct comparison between different studies may not be appropriate due to the different designs of the studies, and different populations with corticosteroid intakes, it is possible that there are ethnic differences that may account for the finding. However, the BMD of Asian women differed little from that of Caucasian women after adjustment for body size[31], and the prevalence of vertebral deformity in postmenopausal women aged above 50 years was actually very similar across different ethnic groups[32]. It nonetheless appears that corticosteroids have an effect on bone resulting in vertebral fractures irrespective of age. A possible explanation for the higher prevalence of vertebral fractures in the other studies may be related to mechanical stresses from loading, as younger patients may be more physically active[33]. Other possibilities may include differences in bone quantity such as microarchitecture, microdamage, bone turnover, bone mineralization, cortical porosity, osteocyte health, bone marrow cellularity, and other aspects of the bone microenvironment[34].

The finding of patients with normal BMD who experienced fracture in our study is consistent with other studies in the general population, that the proportion of fractures attributable to osteoporosis is modest, ranging from 10% to 44%[35]. This underscores the limited value of BMD measurements by DEXA in the prediction of vertebral fracture. The finding that patients with vertebral deformities have higher vitamin D levels, and that fewer of them used sunscreen, compared to those without deformities can be explained by the fact that a greater proportion of patients with fractures were taking vitamin D supplements (42% vs 23%) and had a longer daily exposure to the sun (1.3 ± 1.9 vs 0.98 ± 1.0 h/day) than those who did not have vertebral fractures. Previous studies also documented an association between corticosteroid use and symptomatic fractures in SLE, although we were unable to detect this as a predictor for fractures because the proportion of patients and the cumulative dosages of corticosteroids in both fracture and nonfracture groups were not significantly different.

We attempted but failed to uncover other possible associating novel risk factors for fractures in patients with SLE. OPG has been recently identified as playing an essential role in the balance of bone remodeling[36] and its levels are independently associated with bone mass and fractures in postmenopausal women[23]. It acts by binding and neutralizing RANKL, which binds to RANK on the surface of pre-osteoclasts that mediate the effects of several important stimulators of osteoclastogenesis or prevent increased bone resorption[37,38]. Serum OPG was strongly associated with fracture in our univariate analysis but not in the multivariate analy-

Table 5. Independent explanatory variables associated with vertebral deformities.

Variable	B	SE	OR	95% CI	p
Age	0.066	0.028	1.068	1.01–1.13	0.017
BMI	0.154	0.070	1.166	1.02–1.33	0.036
L1–L4 BMD	–5.319	1.779	0.005	0.00–0.12	0.005

BMD: Bone mineral density; B: regression coefficient (considered in the multiple regression model); SE: standard error of B; BMI: body mass index.

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sis. Low levels of serum RANKL were found to be associated with enhanced fracture risk[39], possibly due to a low degree of bone remodeling and therefore unfavorable bone microarchitecture, although we were unable to substantiate this in our study. ß-CTX was shown to be a potentially useful tool for assessing bone resorption state, including its response to estrogen replacement therapy in patients with metabolic bone diseases such as hyperparathyroidism, chronic renal failure on hemodialysis, hypoparathyroidism, and pseudohypoparathyroidism[24]. However, no significant association between ß-CTX and fractures was found in our study. It is possible that ß-CTX is not useful for the detection of vertebral fractures in corticosteroid-induced osteoporotic bone diseases.

There are limitations in our study design including not having a matched control group for comparison. The method used to assess daily dietary calcium intake included questionnaires consisting of only 17 simple questions; this was oversimplified and suggests an underestimation of the daily dietary calcium intake, as none of the patients was anorexic. The fact that patients were older, and more than half were postmenopausal, restricts the clinical value of our results. Nonetheless, there is a need to recognize a potentially preventable complication, especially because fractures are the leading cause of morbidity among postmenopausal women over age 55 in the general population[40,41]. The finding of higher BMI in patients with fractures is puzzling and did not reflect overall corticosteroid use; perhaps better characterization of body mass composition using waist-to-hip ratio could have been used. Finally, we did not include other classical bone formation markers such as bone alkaline phosphatase, osteocalcin, or type I procollagen N- or C-propeptide measurements.

We have found from this study that (1) asymptomatic vertebral fractures occurred in 20.4% of patients with SLE; (2) most fractures were in thoracic vertebrae; (3) Grade 1 fractures were most common; (4) fractures occurred in 30% of patients with normal BMD; and (5) independent explanatory variables for vertebral deformities in SLE were age, high BMI, and low BMD of the spine. DEXA has a limited value in the prediction of vertebral risks in patients with SLE. A strong recommendation for vertebral morphometry in patients with SLE is needed.

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