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Utility of DXA scanning and risk factors for osteoporosis in ankylosing spondylitis—A prospective study☆

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ABSTRACT

Background: Conventional DXA imaging of spine and hip to measure bone mineral density (BMD) has limitations in patients with ankylosing spondylitis (AS). We investigated the correlation of hip and spine BMD measurements in patients with AS to determine if hip DXA will prove clinically useful while avoiding the confounding effect of spinal disease. Also, we studied risk factors for osteoporosis (OP) and osteopenia in AS.

Methods: We randomly identified patients from our validated AS registry ≥ 18 years of age who met the Modified New York Classification criteria for AS. BMD was measured and interpreted using ISCD 2007 guidelines and diagnosis of OP was based on WHO criteria. ESR, CRP, urinary N-telopeptide, and 25-hydroxy vitamin D were also measured. Correlation between the BMD (total hip and/or femoral neck) and lumbar spine was calculated. Statistical comparisons between the 2 sites, lumbar spine (AP) and hip (total hip and or femoral neck) were made using Bowker's test for symmetry and kappa statistics. Chi-square and odds ratio using logistic regression were used to assess the association of the purported risk factors for OP in these patients.

Results: Frequency of OP among AS patients ≥ 50 years of age was 23%, and that of osteopenia was 41%. Among patients < 50 years of age, the frequency of low bone mass for expected age (Z-score ≤ -2.0) was 14.7%. There was moderate correlation ($\rho = 0.59$) and a fair agreement ($\kappa = 0.26$; 95% CI: 0.10–0.42) between the lowest T-values of hip and lumbar spine (AP view). OP was significantly associated with elevated CRP level [OR = 4.2 (95% CI: 1.13–15.9), $p < 0.03$] and African American race [OR = 7.2 (95% CI: 1.18–44.99), $p < 0.03$].

Conclusion: Our results demonstrated a moderate correlation and fair agreement between the T-scores of hip and the lumbar spine (AP view) in patients with AS, suggesting that DXA of the hip and the lumbar spine (AP view) may both be useful for OP and osteopenia screening in patients with AS without fused spines. We confirm the previous reports of an association of elevated CRP level with an increased risk of OP in patients with AS, but this is the first study to demonstrate that African American patients with AS may be at a higher risk of developing OP compared to Caucasians.

Introduction

Ankylosing spondylitis (AS) is a chronic inflammatory arthritis with increased risk of vertebral compression fractures. Osteoporosis (OP) is a well-recognized complication of AS even in the early stages of the disease [1–8] and increases the fracture risk substantially [9–16]. In patients with vertebral OP and a fused spine, relatively minor physical trauma can lead to spinal fracture and any associated dislocation can result in spinal cord compression with resultant paraplegia or quadriplegia. Early recognition of OP followed by timely and effective treatment and along with prevention of physical trauma may reduce the fracture risk in patients with AS. However, this needs to be confirmed.

Dual X-ray absorptiometry (DXA) is a cost-effective, standardized, and easily available test for OP screening. It has become the gold standard for assessing bone mineral density (BMD) in clinical practice. However, this method has some limitations in patients with AS, particularly related to projection; spinal DXA measurements in anteroposterior (AP) projection are not reliable and may give falsely elevated results due to syndesmophyte formation and ligament ossification. Several studies have confirmed that BMD at the spine in patients with AS is decreased in

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early disease and falsely increased with advanced disease [17,18]. Hence, alternative imaging techniques or sites are needed for measuring BMD in patients with advanced AS.

Femoral neck BMD is also reduced in patients with AS, both with early and advanced disease and correlates with increased risk of vertebral fractures [9,19,20]. BMD has been shown to fall at 2 years at the femoral neck (but not spine) and was proportional to the degree of inflammation [21]. Hence, measurement of hip BMD (total hip or femoral neck) may be the most accurate means of detecting osteopenia or OP in patients with AS.

The aims of our study were (i) to determine the concordance of the hip (total hip or femoral neck) and AP lumbar spine BMD measurements in patients with AS, (ii) to study the risk factors of OP in patients with AS.

Methods

Subjects were randomly identified from our validated AS registry at MetroHealth Medical Center (MHMC) and recruited for the study if >18 years of age and met the Modified New York Classification Criteria of AS [22]. The registry includes 250 subjects with AS, one-third of the subjects are African Americans. About 75–100 of these patients are actively followed at MHMC.

Subjects with (i) thyroid or parathyroid disorders, chronic liver or kidney disease, or use of anti-convulsants medications as they increase the risk of OP, (ii) with bilateral total hip arthroplasties, (iii) completely fused lumbar spines were excluded from the study. The study was approved by our Institutional Review Board.

Informed consent was obtained and subjects were prospectively recruited over a period of 18 months till our sample size of 100 patients was reached.

Data collection

Patient were examined in the Clinical Research unit by either the Principal Investigator (PI) or the Co-PI. Disease activity at baseline was assessed with a validated patient-reported index, the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI). The following variables were collected: age, gender, duration of disease, HLA-B27 status, current smoking status, and use of non-steroidal anti-inflammatory medications and glucocorticoids ≥ 5 mg for more than 3 months. History of previous fragility fractures and family history of OP and fractures was also obtained. All this information was captured using a questionnaire and entered into RedCap database.

Radiographs and DXA scanning

BMD of the lumbar spine in the AP projection (L1–L4), the hip (femoral neck and total hip) were measured using a DXA scanner (Hologic Discovery). DXA images were reviewed by the PI who was certified by International Society of Clinical Densitometry (ISCD) in reading DXA scans. For patients aged 50 years or older the following World Health Organization (WHO) definitions of osteopenia and osteoporosis were used: osteopenia = T-score < -1 to > -2.5 SD (compared to the young normal mean), and osteoporosis = T-score ≤ -2.5 SD. The lowest value of BMD measured in the AP lumbar spine (L1–L4), or total hip or femoral neck was used [23] for detecting the frequency of OP. For patients under the age of 50 a Z-score ≤ -2.0 SD (compared to the age-matched mean) was considered to be below the expected range for age [24].

Patients had a baseline radiograph of lumbar spine in 2 planes (AP and lateral) to assess the presence of definite syndesmophytes in case radiographs were not available in existing medical records or the radiographs were more than 5 years old. The radiograph was done on the same day as the DXA scan. The radiographs were reviewed by the investigators and an independent radiologist. The modified Stoke Ankylosing Spondylitis Spinal Score (mSASSS), a four-point scoring system for lateral radiographs of the lumbar spine was performed. A total score was obtained by multiplying the mean score of all scored sites by 12 (highest possible score of 36).

Laboratory measurements

Erythrocytic sedimentation rate (ESR) and serum concentration of C-reactive protein (CRP), alkaline phosphatase, parathyroid hormone (PTH), 25-hydroxyl vitamin D level, and urinary N-telopeptide (NTX) were measured in the hospital laboratory by established methods.

Stastistical analysis

Descriptive analysis included continuous variables (the mean $\pm$ SD) and the categorical variables percentage. Data were compared by Student's t-test and Mann–Whitney test for continuous variables. Coding for categorical variables was yes = 1, no = 2, and data missing = 3. Association between OP diagnosis and categorical variables was assessed using Chi-square test. Correlations between BMD at different sites were derived using Spearman's correlation coefficients (rs). Statistical comparisons between the 2 sites, lumbar spine (AP), and hip (total hip or femoral neck) were made using Bowker's test for symmetry and kappa statistics.

Multivariate logistic regression models were adopted to identify risk factors for OP in AS. Results of the regression models are shown as the odds ratio (OD) and 95% CI. In all the statistical tests the level of significance was set at 5% ($p < 0.05$). SAS software was used for statistical analysis.

Results

A total of, 101 patients met the inclusion criteria and completed the study with 39 patients >50 years of age. Demographics and clinical characteristics of these patients are shown in Table 1. No significant differences were found in demographic, disease duration, BASDAI scores, or health status of patients with OP,

Table 1
Demographics and baseline characteristics of the patients

	Patients with OP and osteopenia or low bone mass (T-score < -1 or Z-score < -2) ($n = 54$)	Patients with normal BMD (T-score > -1) ($n = 47$)	p
Age in years $\pm$ SD	47.8 $\pm$ 14.43	43.09 $\pm$ 13.70	0.08
% males	79.63	65.96	0.12
% African Americans	26.42	25.53	0.92
% Disease duration >5 years	85.19	80.85	0.56
% Smokers	62.96	65.96	0.75
% HLA-B27 positivity	54.55	65.00	0.33
Mean BASDAI	5.42 $\pm$ 2.43	5.57 $\pm$ 2.64	0.81
25-hydroxyl vitamin D	30.28 $\pm$ 24.49	28.85 $\pm$ 16.50	0.67
Mean ESR in mm/h	20.96 $\pm$ 25.84	16.43 $\pm$ 15.81	0.95
Mean CRP in mg/dl	1.44 $\pm$ 2.57	0.79 $\pm$ 0.72	0.02

Table 2
Clinical and disease characteristics and of African American versus Caucasian patients

	Caucasians	African Americans	*p*
% HLA-B27 positivity	64.62	42.11	0.07
Mean BASDAI	5.37 ± 2.33	5.46 ± 3.02	0.8
Mean ESR in mm/h	16.06 ± 21.74	25.03 ± 20.32	0.06
Mean CRP in mg/dl	1.11 ± 2.18	1.19 ± 1.11	0.86
Mean mSASS	8.72 ± 7.47	8.18 ± 7.71	0.77

osteopenia or low bone mass for expected age compared to patients with normal BMD.

The mean age ± SD was 43.0 years (± 13.7) in patients with normal BMD versus 47.8 years (± 14.4) with OP, osteopenia, and low bone mass for expected age ($p = 0.0867$). Predominant patients were Caucasian males with only 26.7% females, and 26% of patients were African Americans (AA). There was no significant difference between the African American and Caucasian groups in terms of disease activity as measured by BASDAI or in spine scores as shown in Table 2. About 42.1% African American patients were HLA-B27 positive compared to 64.6% Caucasians but this difference was not significant with $p = 0.07$.

All of the patients had axial disease and only 21.5% had peripheral joint involvement. Uveitis was present in 23.4%, inflammatory bowel disease in 9.7% and psoriatic skin disease in 6.7% of the total patients. Overall, 83% of patients had disease duration greater than 5 years, 40.5% with syndesmophytes on lateral lumbar spine radiograph and 59.5% of patients were HLA-B27 positive. There was no significant difference in the mSASS scores of the 3 groups with mean mSASS score and SD of 10.1 ± 8.0 in patients with OP, 9.6 ± 8.6 in patients with osteopenia and 7.1 ± 6.2 in patients with normal BMD ($p = 0.43$).

Disease activity was high in both groups of patients; the mean BASDAI was 5.42 ± 2.4 in patients with OP and osteopenia and 5.57 ± 2.6 in patients with normal bone mineral density ($p = 0.81$). All the patients were taking non-steroidal anti-inflammatory medications but none of the patients were taking prednisone ≥ 5 mg for 3 or more months. However, 28.2% of patients were using anti-TNF therapy.

The results of blood and urine tests are shown in Table 3. Mean CRP mg/dl levels ± SD were higher in patients with OP, osteopenia, and low bone mass for expected age (1.44 ± 2.57) compared to patient with normal BMD (0.70 ± 0.72) with $p < 0.02$.

Correlation between BMD of lumbar spine and hip

Frequency of OP and osteopenia among all patients ≥ 50 years of age was 23% (17.9% males and 15.3% AA) and 41% (30.7% males and 7.6% AA) based on WHO criteria. In these patient, the median BMD at the AP lumbar spine L1–L4 = 1.005 g/cm² [interquartile range (IQR): 0.94–1.19] and at total hip or femoral neck = 0.806 g/cm² (IQR: 0.72–0.91). Using Spearman's correlation coefficient, there was a moderate correlation between the BMD of the lumbar spine AP projection and the hip (total hip or femoral neck) with $r = 0.60$ and $p < 0.0001$.

Among patients < 50 years of age, the frequency of low bone mass for expected age (*Z*-score ≤ −2.0) was 14.7%.

In 37 patients ≥ 50 years of age BMD measurements based on lumbar spine (AP projection) versus hip (total hip or femoral neck) revealed OP in 10.8% versus 16.2%, osteopenia in 51.3% versus 24.3% and normal BMD in 37.8% versus 59.4%. It appears that the trend was that the proportion of osteoporotic patients was more at the hips and osteopenic patients more at the lumbar spine, however, statistically the discordance observed between the 3 groups at the two sites was insignificant with (st = 6.054) $p < 0.10$. Also, using Kappa statistics there was a fair agreement between the two sites with weighted kappa = 0.23 (95% CI 0.01–0.45).

Among all 101 patients, the mean BMD ± SD at the lumbar spine (AP projection) was 1.759 g/cm² ± 6.87 and at total hip or femoral neck = 0.827 g/cm² ± 0.143. There was a moderate correlation between the BMD of the lumbar spine (AP projection) and the hip (total hip or femoral neck) with $r = 0.62$ and $p < 0.0001$. A correlation was also found between the lowest *T*-values of hip and lumbar spine (AP view), $r = 0.59$ (Fig.). In all patients, BMD measurements based on lumbar spine (AP projection) versus hip (total hip or femoral neck) revealed OP in 4.3% versus 9.6%, osteopenia in 41.9% versus 26.8%, normal BMD in 53.7% versus 63.4%. There was a fair agreement between the two sites with kappa = 0.26 (95% CI 0.10–0.42).

There were six patients which showed discordance between the lowest *T*-values of lumbar spine (AP projection) and hip (total hip or femoral neck). The characteristics and lumbar spine radiographic findings of these patients are shown in Table 4.

Risk factors for osteoporosis in AS

Multivariate analysis was done with 2 models—in the first model as shown in Table 5, using osteoporosis, osteopenia as the outcome, there was an association between African American race and OP + osteopenia but this association was not significant [OR = 1.5 (95% CI: 0.5–4.5), $p < 0.45$]. However, in model 2 as shown in Table 6 using OP as the only outcome, African American race [OR = 7.2 (95% CI: 1.1–44.9), $p < 0.03$] and elevated CRP levels were significantly associated with OP [OR = 4.2 (95% CI: 1.1–15.9), $p < 0.03$].

There was no significant association between age, sex, BASDI, vitamin D levels, smoking, HLA-B27 positivity, ESR measurements, and risk of OP in patients with AS. The odds of developing osteoporosis seemed to decrease with use of TNF inhibitors but the difference was not significant [OR = 0.50 (95% CI: 0.04–5.86), $p < 0.58$].

Discussion

Osteoporosis and osteopenia are well-recognized complications of AS and substantially increase the risk of vertebral compression fractures. The present study confirmed that the risk of OP and osteopenia is high in patients with AS with a reported frequency of 23% and 41% in patients ≥ 50 years of age based on WHO criteria for OP. In patients < 50 years of age low bone mass for expected age (*Z*-score ≤ −2.0) was present in 14.7%. This is similar to other studies where the reported prevalence of OP and osteopenia in AS varies between 13% and 25% (6–8). In a multicenter study of 204 patients with AS from western Sweden OP was seen in 21% of patients [7]. Another prospective study on 80 AS patients in a Moroccan study revealed a prevalence of 25%.

OP and osteopenia is a recognized co-morbidity in rheumatoid arthritis (RA) and low bone mass in male patients with RA has been reported between 30% and 33% [25]. Based on the current

Table 3
Laboratory investigations

CRP (mg/dl)	1.14 ± 1.95
N-telopeptide (nM/mM creat)	49.1 ± 33
25-hydroxy vitamin D (ng/ml)	29.5 ± 20.7
Parathyroid hormone (pg/ml)	41.5 ± 20.0
Alkaline phosphatase (μg/l)	75.8 ± 27.5

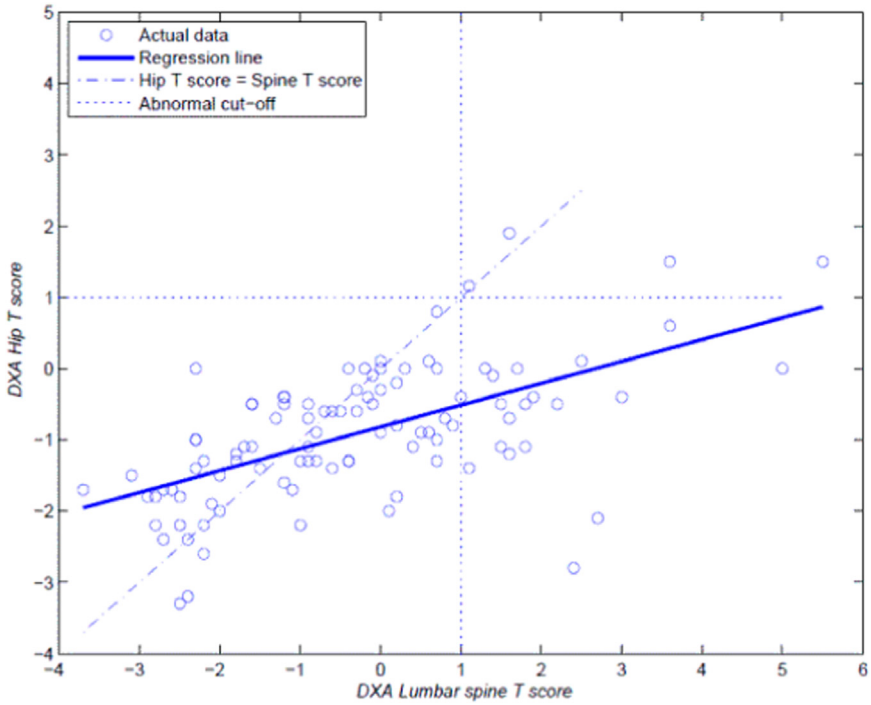

Fig. Correlation between *T*-score of Lumbar spine and total hip or femoral neck.

study the burden of OP in AS may be higher than RA even though glucocorticoids are minimally used in treatment of AS. The paradoxical bone loss juxtaposed with excessive bone formation in AS suggests uncoupling of bone formation and resorption [26,27]. Significantly lower levels of serum osteoprotegerin (OPG), an essential cytokine for RANK–RANK-L interaction, have been detected in AS patients compared with controls; suggesting a relative lack of this bone resorption antagonist [28]. This was confirmed in another study which measured markers of bone turnover including OPG, soluble receptor activator of nuclear factor kappa-B ligand (sRANKL), sclerostin, Dickkopf-related protein 1 (DKK-1), NTX, and interferon-γ (IFNγ) in AS patients and controls [29]. A similar levels of NTX, sRANKL, sclerostin, DKK-1, bone specific alkaline phosphatase (BAP), and IFNγ were found between the 2 groups; however, OPG levels were significantly lower in the AS group. Another proposed model for increased bone resorption in AS is supposedly mediated by overexpression of IL-17 through alterations in the RANKL/OPG ratio [30].

Genetic factors may also contribute to the risk of OP in AS. Vitamin D receptor (VDR) gene polymorphisms have been associated with the pathogenesis of OP. The FokI genotype of the VDR gene is related to bone mass at the hip, and an association of VDR FokI polymorphisms with low BMD has been found in male AS patients [30]. Also, a significant correlation has been found between FokI genotypes and parameters of inflammation in AS patients [31]. Sub clinical bowel inflammation and inflammatory bowel disease mediated by IL-23 has been shown to occur in patients with AS [32]. This could possibly result in impaired calcium and vitamin D absorption.

Contrary to our hypothesis, an important observation of this prospective study was that a moderate correlation was seen between the lowest *T*-values of hip (total hip or femoral neck and the lumbar spine (AP view) in all patients. There was also a fair agreement of *T*-scores between the two sites and a similar agreement was also seen between the *T*-scores of patients ≥ 50 years of age among the two sites. Similar results were seen in a previous study where correlation between *T* scores (by DXA) at the lumbar spine and the neck of femur was good (Spearman correlation coefficient $r = 0.69$, $p = 0.003$) [33]. However, this previous study revealed that low bone density (osteopenia or osteoporosis) was significantly more common at the femoral neck (measured by DXA) than at the AP lumbar spine (chi-square $= 20.11$, $p < 0.001$) [33]. A systematic review of 7 studies that included patients with AS based on the Modified New York Classification Criteria of AS [22] and WHO criteria for definition of OP and osteopenia revealed the overall prevalence of decreased BMD comparable between the 2 sites; 54% for lumbar spine and 51% for femoral neck [6]. The prevalence of osteopenia versus OP for lumbar spine was 39%

Table 4
Characteristics and lumbar radiographic findings of patients with discordance of *T*-score values between lumbar spine and hip

Patient	Age	Lowest *T* score (lumbar spine AP)	Lowest *T* score (total hip or femoral neck)	HLA-B27	Radiographic finding of lumbar spine
1	57	1.1	−1.4	+	Extensive ossification of the anterior longitudinal ligament and classic syndesmophytes. Disc space narrowing from L2–S1 with large osteophytes at L1–L2 from degenerative arthritis
2	52	2.4	−2.8	+	Tram track calcification of ligaments with classic syndesmophytes. Calcification of the intervertebral discs.
3	47	1.5	−1.1	−	Classic syndesmophytes. Prominent osteophytes at L4–L5 from degenerative arthritis
4	34	1.6	−1.2	+	Infiltrative process in the spinal cord and bone
5	52	2.7	−2.1	+	Prominent syndesmophytes at all levels
6	72	1.8	−1.1	+	L1–L2 and degenerative arthritis

Table 5
Model 1—OR calculated using logistic regression analysis and the outcome was OP and osteopenia

Effect	OR	95% Confidence limits	p Value (χ^2)
Age	1.02	(0.99–1.06)	0.14
Sex			
Female vs. male	0.44	(0.13–1.46)	0.18
Race			
African American vs. White	1.51	(0.50–4.54)	0.45
Disease duration			
>5 years vs. <5 years	1.08	(0.31–3.71)	0.89
Vitamin D levels	1.01	(0.98–1.03)	0.37
BASDAI	1.03	(0.86–1.25)	0.69
ESR, mm/h	0.98	(0.94–1.01)	0.34
CRP, mg/dl	1.79	(0.83–3.88)	0.13
HLA-B27_positive	1.35	(0.67–2.68)	0.39
Smoking			
Yes vs. no	0.85	(0.31–2.31)	0.76
Use of TNF inhibitors			
Yes vs. no	1.44	(0.50–4.10)	0.49

versus 16% and for femoral neck, 38 versus 13% [6]. There results of our study concur with the results of the systematic review.

Previous studies have also shown that in patients with AS, trabecular bone loss may occur more frequently in the lumbar spine [15,17,18,34,35] compared to hip and peripheral sites. A recent study revealed that trabecular bone loss in AS affects both axial and peripheral skeleton [36]. A strong correlation was found between the spinal and peripheral trabecular vBMD in AS patients. The current study did not reveal a significant difference in bone mineral density among the 2 sites. There were only six patients that showed discordance with increased BMD in the lumbar spine but bone loss at the hip. The radiographs of the lumbar spine in all these patients revealed superimposed degenerative disc disease along with syndesmophytes resulting in increased BMD in the lumbar spine.

Based on the current study, routine DXA imaging of the lumbar spine (AP projection) and the hip may both be useful for OP and osteopenia screening in patients with AS >50 years of age who have not yet completely ankylosed the spine. Lateral lumbar spine DXA has been shown to be more sensitive than AP DXA in detecting osteoporosis and osteopenia in AS, as it only measures trabecular bone without measuring the cortical bone of the vertebral bodies [7,37–39]. Hence, lateral lumbar DXA projections could serve as a screening tool in patients with late stage AS in whom syndesmophytes are present [38]. However, as per ISCD guidelines lateral lumbar DXA cannot be used for diagnosis of osteoporosis due to the absence of a reference-population database regarding lateral lumbar DXA [40]. Lateral lumbar DXA may have a role in monitoring OP [40]. Alternatively, quantitative computed tomography (QCT) has the advantage of assessing volumetric BMD in the lumbar spine and measures cortical and trabecular bone separately, without including areas of hyperostosis in the measurements [36,41,42]. Nevertheless, its use has been limited due to slightly increased radiation exposure (2–10 mSv) and high cost of the test. Opportunistic computed tomography screening could be used as an alternative. A recent small study of 17 patients with severe AS and bridging syndesmophytes who presented with acute fractures of the spine were studied [42]. All of these patients had a CT scan either 6 months prior or after injury that included an image of the L1 vertebra. Using a CT attenuation threshold for higher sensitivity (160 HU), 15 of 17 (88%) patients were osteoporotic. This method may detect more cases of OP but a prior CT scan of the spine has to be available.

We demonstrated for the first time a significant association between African American race and the risk of OP in patients with AS. This is contrary to what is seen in the general population where African American subjects have higher BMD than Caucasians [43]. Plausible explanations for this accelerated bone loss seen in African American patients with AS could be a result of greater disease severity, which possibly may be genetically mediated [44] or a result of relatively inadequate management of their disease. This needs to be investigated further in future studies. The current study revealed no difference in disease activity between African American versus Caucasian patients as measured by BASDAI to explain the accelerated bone loss.

Our study also revealed a strong association between the levels of CRP and OP in patients with AS. This finding confirms the results of previous studies that have also shown an association between CRP and risk of OP in AS [7,10,20,45]. Elevated CRP levels are a reflection of inflammation and trabecular bone loss mediated by increased number of osteoclasts seen in the axial skeleton of patients with AS [46].

The study did not reveal any association between OP and age, sex of the patient, BASDI, vitamin D levels, HLA-B27 positivity, and ESR measurements. Use of TNF-α inhibitors has been shown to increase BMD of the lumbar spine and total hip and maintain femoral neck BMD for up to 2 years in patients with AS [47,48]. A recent meta-analysis that looked at the impact of antirheumatic drugs on BMD in AS showed that use of TNF-α was associated with increased BMD at both the lumbar spine and hip [48]. This study also showed that use of TNF-α inhibitor was associated with decreased risk of OP but the association was not statistically significant. TNF-α inhibitors likely improve BMD in patients with AS by directly decreasing the bone resorption and increasing bone formation by alleviating the RANK/RANKL pathway. It needs to be determined whether the effect of the improvement in BMD with TNF-α inhibitors will decreases the fracture outcomes.

The results of the study have to be interpreted in the context of few limitations. Firstly, the cohort included patients from a single, urban public hospital and secondly, 59.5% of the patients did not have syndesmophytes on lateral lumbar spine that may have resulted in this fair agreement and insignificant discordance between the BMD of the lumbar spine and hip. Also, patients with completely fused spines were excluded from the study. Although the study showed an association between AA race and the risk of OP in patients with AS but our sample included only 26 AA patients, hence we may not be able to generalize the results and further studies are needed in AA patients. The cross sectional design of our study has some limitations as covariates like BASDAI and use of TNF-α inhibitor use were not assessed over a period of

Table 6
Model 2—odds ratio (OR) calculated using logistic regression analysis and the outcome was OP alone

Effect	OR	95% Confidence limits	p Value (χ^2)
Age	1.05	(0.98–1.12)	0.13
Sex			
Female vs. male	1.02	(0.15–6.71)	0.97
Race			
African American vs. White	7.29	(1.18–44.99)	0.03
Vitamin_D	0.99	(0.93–1.05)	0.73
BASDAI	1.17	(0.84–1.64)	0.34
ESR, mm/h	0.94	(0.87–1.00)	0.08
CRP, mg/dl	4.25	(1.13–15.91)	0.03
HLA-B27_positive	1.43	(0.47–4.38)	0.52
Smoking			
Yes vs. no	2.40	(0.35–16.21)	0.36
Use of TNF inhibitors			
Yes vs. no	0.50	(0.04–5.86)	0.58

time. Also, the degree of functional limitation in patients was not measured. However, this prospective study included a unique sample of AS patients with 26% females and 26% AA. Most studies that have reported the prevalence of OP in AS have included mainly Caucasian patients and henceforth, not much is known about the risk of OP in AA patients with AS.

Many rheumatologists do not routinely assess patients with AS for OP, as there are no existing guidelines and most of the patients are young men who are less likely to be screened [49,50]. The second important question is; which patients with AS should undergo BMD measurement? There are no set criteria at present for identifying patients with AS who need BMD measurements but following recommendations have been proposed [3]: (i) risk factors for osteoporosis such as positive family history, advanced age, low body mass index, Caucasian and South Asian ethnicity, severe immobility, low androgen level in men, post–menopausal status in women, vitamin D deficiency, or glucocorticoid treatment, (ii) active disease with increased inflammatory parameters and elevated markers of bone resorption. (iii) bone loss (osteopenia) and vertebral compression fractures on plain radiographs, and (iv) severe AS with thoracic kyphosis, extensive syndesmophyte formation, and spinal restriction of movement.

Conclusion

The prevalence of OP and osteopenia in AS patients is high. Routine DXA imaging of the lumbar spine (AP projection) and the hip may be a useful screening tool for OP in patients with AS >50 years of age without completely fused spine. African American patients with AS may be at more risk than Caucasian patients of developing osteopenia and OP. All AS patients who are over the age of 50 years or with history of vertebral compression fractures should be screened for OP using routine DXA. In AS patients with completely fused spine or co-existing degenerative disc disease alternate screening methods need to be used.

Significance of the Study

(1) Risk of osteoporosis and osteopenia is high in patients with AS with a reported frequency of 23% and 41% in patients ≥ 50 years of age.
(2) Routine DXA imaging of the lumbar spine (AP projection) and the hip may be a useful screening tool for OP in patients with AS >50 years of age without completely fused spine.
(3) This study is first to demonstrate an association between African American race and the risk of OP in patients with AS.

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Author contributions

All authors were involved in revising the article to critically evaluate the important intellectual content, and all authors approved the final version to be submitted for publication.

Dr. Magrey and Mr. Lewis have full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design: Marina N. Magrey

Acquisition of data: Marina N. Magrey and Muhammad A. Khan

Analysis and interpretation of data: Marina N. Magrey and Steven Lewis

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