DOI: 10.7860/JCDR/2019/39690.12544

Original Article

Orthopaedics Section

An Audit of Bone Mineral Density and Associated Factors in Patients with Lumbar Spinal Stenosis

ARASH RAHBAR[1], RAHMATOLLAH JOKAR[2], SEYED MOKHTAR ESMAEILNEJAD-GANJI[3]

ABSTRACT

Introduction: Osteoporosis is a major global health problem and is commonly observed with lumbar stenosis in older people. It is stated that osteoporosis may cause progressive spinal deformities and stenosis in elderly patients.

Aim: To audit prevalence of low bone mineral density and associated factors in patients with lumbar spinal stenosis.

Materials and Methods: Patients with symptomatic lumbar spinal stenosis were recruited in this cross-sectional study, who had been referred to Shahid Beheshti hospital in Babol, Northern Iran, between 2016 and 2017. Lumbar spinal stenosis was diagnosed based on clinical symptoms and a stenotic lesion in the lumbar spine confirmed by magnetic resonance imaging. Low bone mineral density was confirmed based on World Health Organisation and International Society for Clinical Densitometry criteria. Demographic and laboratory parameters of the patients were collected. The data were analysed using SPSS by descriptive, ANOVA, logistic regression and Pearson correlation tests.

Results: Overall, 146 patients with lumbar stenosis were enrolled. Based on bone densitometry of spine and femur, 35 (24%) and 36 (24.7%) of the patients had osteoporosis. According to femoral densitometry, age (OR=1.311, 95% CI: 1.167-1.473), being a female (OR=3.391, 95% CI: 1.391-8.420) and being a homemaker (OR=3.675, 95% CI: 1.476-9.146) were found as risk factors for osteoporosis. Based on spinal densitometry, age (OR=1.283, 95% CI: 1.154-1.427) and being a female (OR=2.786, 95% CI: 1.106-7.019) were associated with osteoporosis. Significant correlations were observed between bone mineral density and red blood cell counts (r=+0.168, p=0.043) and vitamin D (r=+0.303, p<0.001).

Conclusion: The prevalence of low bone mineral density was considerable in the patients with lumbar spinal stenosis. Control of modifiable associated factors by physicians and healthcare administrators should lead to a better outcome of the disease in these patients.

Keywords: Densitometry, Osteoporosis, Spine

INTRODUCTION

Lumbar spinal stenosis is one of the common musculoskeletal disorders worldwide, in which the lumbar vertebral canal narrows and compresses the spinal cord. It often results from spinal degenerative changes which occur with aging, especially in postmenopausal females [1,2]. This disorder can be seen on its own, or with a herniated disc [2,3]. The treatment can be conservative (resting, brace, analgesics and antispasmodic medication) or surgical. Surgery is indicated in patients with limping, uncontrollable pain, neurologic damage and/or myelopathy [4,5].

Several factors can play role in occurrence of lumbar spinal stenosis, such as age, trauma, diabetes and obesity [6-8]. Low bone mineral density is another leading factor [9,10]. Osteoporosis is a major global health problem and is one of the most common bone metabolic diseases in adults, particularly in the postmenopausal females [1,11,12]. Osteoporosis and lumbar stenosis are commonly observed in older people. Osteoporosis may cause progressive spinal deformities and stenosis in elderly patients, and is usually considered as a contraindication for spinal surgery [9]. Therefore, identifying the factors associated with osteoporosis and controlling them are important, and should help in the prevention of bone degenerative diseases and their undesirable outcomes.

There are limited studies assessing the factors associated with bone mass in the patients with lumbar spinal stenosis [13,14]. Hence, we aimed to investigate the status of bone mineral density and the related factors in this group of patients.

MATERIALS AND METHODS

This cross-sectional study was conducted on patients with symptomatic lumbar spinal stenosis who were referred to Shahid Beheshti Teaching Hospital in Babol, Northern Iran, between 2016 and 2017. The patients with history of diabetes, trauma, infectious and/or rheumatologic diseases, tumour and/or any space-occupying lesions of the spinal cord were excluded from the study.

Plain radiography and Magnetic Resonance Imaging (MRI) of lumbosacral spine were performed on all the patients. Lumbar spinal stenosis was diagnosed by a single orthopaedic surgeon not only based on the clinical symptoms, but also a stenotic lesion in the lumbar spine confirmed by MRI. The stenotic lesion was defined as the mid-sagittal diameter being smaller than 12 mm in the MRI [15]. The clinical symptoms included intermittent limping, backache into the lower limbs, muscle cramp in the feet with paraesthesia in the affected foot, the symptoms of shortening the hamstring muscles, pain and limitation in the mentioned muscles, improvement of a patient's pain by a squat or bending the waist, an increase in the symptoms with walking, and improvement of the symptoms with sitting.

In order to measure the bone mineral density, dual-energy X-ray absorptiometry was used on lumbar spine and femoral neck with a Lunar DPX-MD instrument. The osteoporosis in postmenopausal females and men aged ≥50-years-old was based on World Health Organisation definition which is T-score ≤-2.5 Standard Deviation (SD) [16]. Osteopenia was defined as a T-score >-2.5 SD and <-1.0 SD, and normal bone as a T-score ≥-1.0 SD. The definition of osteoporosis in premenopausal females and in men under 50-years-old was based on International Society for Clinical Densitometry criteria, which is the presence of fragility fractures and a Z-score ≤-2 SD [17].

The patients' information was recorded by a predesigned checklist, including gender (males/females), age, body mass index,

occupation (self-employment/homemaker/employee), residence (rural/urban), smoking (no/yes), alcohol (no/yes), opioids (no/yes), use of anticonvulsants (no/yes), pregnancy (no/yes), menopause (no/yes), and oophorectomy history (no/yes). Laboratory tests were also collected, including fasting blood sugar, erythrocyte sedimentation rate, complete blood count, and vitamin D. All of the patients were informed of the design and aim of the study, and the written consent was obtained from them. The patients' information was kept confidential. This study was approved by the Ethical Research Committee of Babol University of Medical Sciences (code: MUBABOL.HRI.REC.1396.25).

STATISTICAL ANALYSIS

The collected data were analysed by SPSS v19 statistical software. The descriptive analysis was used to determine the frequency, percentages, mean and SD. For the analysis of quantitative variables between the groups of bone mineral density, ANOVA test was used. The Odds Ratio (OR) and 95% Confidence Interval (CI) were computed with logistic regression (the group with normal bone mineral density was served as the reference). The Pearson correlation test was used to measure the linear association between bone mineral density and laboratory parameters. A value of $p<0.05$ was accepted as significant.

RESULTS

Patients' Characteristics and Prevalence of Low Bone Density

Initially, 203 patients were diagnosed with lumbar canal stenosis, and finally 146 were eligible and included in this study, of whom 58 (39.7%) were males and 88 (60.3%) were females. The mean age was 60.01±26.34-years-old, ranging 41-85-years-old. According to the spinal densitometry, 56 (38.4%) and 35 (24%) patients had osteopenia and osteoporosis, and others (37.6%) had normal bone density. Based on the femoral densitometry, 57 (39%) and 36 (24.7%) patients were osteopenic and osteoporotic, and others (36.3%) had normal bone density. [Table/Fig-1,2] shows the distribution of low bone mineral density by patients' characteristics.

Variables	Spinal bone mineral density measurement		
Males and females	Normal (n, %)	Osteopenia (n, %)	Osteoporosis (n, %)
Age (years-old, mean±SD*)	55.75±7.108	60.09±8.679	66.60±6.103
BMI (Kg/m², mean±SD)**	27.035±3.0760	25.620±3.1641	26.935±3.2570
Gender			
Male	27 (46.6)	22 (37.9)	9 (15.5)
Female	28 (31.8)	34 (38.6)	26 (29.5)
Occupation			
Self-employment	31 (47.7)	24 (36.9)	10 (15.4)
Homemaker	22 (29.3)	29 (38.7)	24 (32)
Employee	2 (33.3)	3 (50)	1 (16.7)
Residence			
Rural	15 (28.8)	22 (42.3)	15 (28.8)
Urban	40 (42.6)	34 (36.2)	20 (21.3)
Smoking			
No	26 (31.7)	33 (40.2)	23 (28)
Yes	29 (45.3)	23 (36.9)	12 (18.8)
Alcohol			
No	53 (37.6)	54 (38.3)	34 (24.1)
Yes	2 (40)	2 (40)	1 (20)
Opioids			
No	44 (35.8)	50 (40.7)	29 (23.6)
Yes	11 (47.8)	6 (26.1)	6 (26.1)
Anticonvulsants			
No	48 (41.7)	42(36.5)	26(21.7)
Yes	7 (23.3)	14 (46.7)	9 (30)
Only females			
Menopause			
No	12 (46.2)	9 (34.6)	5 (19.2)
Yes	16 (25.8)	25 (40.3)	21 (33.9)
Pregnancy			
No	5 (26.3)	10 (52.6)	4 (21.1)
Yes	23 (33.3)	24 (34.8)	22 (31.9)
Oophorectomy			
No	23 (33.3)	25 (36.2)	21 (30.5)
Yes	5 (26.3)	9 (47.4)	5 (26.3)

[Table/Fig-1]: Distribution of low bone mineral density based on spine densitometry by patients' characteristics.
*Standard deviation; **Body mass index

Variables	Femoral bone mineral density measurement		
Males and females	Normal (n, %)	Osteopenia (n, %)	Osteoporosis (n, %)
Age (years-old, mean±SD*)	55.60±6.823	60.07±8.813	66.42±6.281
BMI (Kg/m², mean±SD)**	27.117±3.0352	25.606±3.2145	26.923±3.2395
Gender			
Male	28 (48.3)	20 (34.5)	10 (17.2)
Female	25 (28.4)	37 (42)	26 (29.6)
Occupation			
Self-employment	32 (49.2)	22 (33.8)	11 (16.9)
Homemaker	19 (25.3)	32 (42.7)	24 (32)
Employee	2 (33.3)	3 (50)	1 (16.7)
Residence			
Rural	16 (30.8)	19 (36.5)	17 (32.7)
Urban	37 (39.4)	38 (40.4)	19 (20.2)
Smoking			
No	27 (32.9)	32 (39)	23 (28)
Yes	26 (40.6)	25 (39.1)	13 (20.3)
Alcohol			
No	51 (36.2)	56 (39.7)	34 (24.1)
Yes	2 (40)	1 (20)	2 (40)
Opioids			
No	44 (35.8)	48 (39)	31 (25.2)
Yes	9 (39.1)	9 (39.1)	5 (21.7)
Anticonvulsants			
No	46 (40)	44 (38.3)	25 (21.7)
Yes	7 (22.6)	13 (41.9)	11 (35.5)
Only females			
Menopause			
No	7 (26.9)	11 (42.3)	8 (30.8)
Yes	18 (29)	26 (42)	18 (29)
Pregnancy			
No	6 (31.6)	9 (47.4)	4 (21.1)
Yes	19 (27.5)	28 (40.6)	22 (31.9)
Oophorectomy			
No	20 (29)	27 (39.1)	22 (31.9)
Yes	5 (26.3)	10 (52.6)	4 (21.1)

[Table/Fig-2]: Distribution of low bone mineral density based on femur densitometry by patients' characteristics.
*Standard deviation; **Body mass index

Variables Associated with Low Bone Density by Spinal Densitometry

As indicated in [Table/Fig-3], logistic regression model revealed that there was a positive association between osteopenia and age (OR=1.073, 95% CI: 1.020-1.130, p=0.007). Conversely, there was a negative association between osteopenia and Body Mass Index (BMI) (OR=0.863, 95% CI: 0.760-0.979, p=0.022). In relation to osteoporosis, age (OR=1.283, 95% CI: 1.154-1.427, p<0.001) and being a female (OR=2.786, 95% CI: 1.106-7.019, p=0.03) were found as risk factors. [Table/Fig-4] shows the relation between laboratory parameters and bone mineral density. Also, based on the Pearson test, Vitamin D was positively correlated with bone mass (r=+0.287, p<0.001).

Variables Associated with Low Bone Density by Femoral Densitometry

According to analyses, age (OR=1.076, 95% CI: 1.022-1.133, p=0.006) and being a homemaker (OR=2.450, 95% CI: 1.117-5.373, p=0.025) were positively associated with osteopenia [Table/Fig-5]. In contrast, BMI had a negative relation with osteopenia (OR=0.866, 95% CI: 0.764-0.981, p=0.024). Regarding osteoporosis, age (OR=1.311, 95% CI: 1.167-1.473, p<0.001), being a female (OR=3.391, 95% CI: 1.391-8.420, p=0.007) and being a homemaker (OR=3.675, 95% CI: 1.476-9.146, p=005) were found as risk factors. Red Blood Cell (RBC), platelet and vitamin D were the laboratory factors associated with bone mineral density [Table/Fig-6]. The Pearson test also showed significant correlations between bone mineral density and RBC counts (r=+0.168, p=0.043) and vitamin D (r=+0.303, p<0.001).

DISCUSSION

In the present study, we investigated prevalence of low bone mineral density and the potential associated factors in the patients with lumbar spinal stenosis. It was found that 24% and 25% of the patients had osteoporosis based on spinal and femoral densitometry, respectively. A survey by Lee BH et al., on 106 patients with lumbar spinal stenosis indicated a rate of 22.6% for osteoporosis in the patients, close to our results [14]. A study by

Variables	Spinal bone mineral density measurement			
	Osteopenia		Osteoporosis	
Males and females	OR*a (95% CI**)	p-value	ORa (95% CI)	p-value
Age (years-old, mean±SD*)**	1.073 (1.020-1.130)	0.007	1.283 (1.154-1.427)	<0.001
BMI** (Kg/m^2, mean±SD)**	0.863 (0.760-0.979)	0.022	0.990 (0.863-1.134)	0.882
Gender				
Male	1		1	
Female	1.490 (0.702-3.164)	0.299	2.786 (1.106-7.019)	0.03
Occupation				
Self-employment	1		1	
Homemaker	1.703 (0.789-3.673)	0.175	1.004 (0.424-2.380)	0.992
Employee	1.938 (0.300-12.532)	0.487	0.781 (0.065-9.340)	0.845
Residence				
Rural	1		1	
Urban	0.580 (0.260-1.290)	0.181	0.500 (0.204-1.223)	0.129
Smoking				
No	1		1	
Yes	0.981 (0.133-7.225)	0.985	0.468 (0.195-1.123)	0.089
Alcohol				
No	1		1	
Yes	0.642 (0.103-3.999)	0.635	0.779 (0.068-8.931)	0.841
Opioids				
No	1		1	
Yes	0.480 (0.164-1.405)	0.180	0.828 (0.276-2.485)	0.736
Anticonvulsants				
No	1		1	
Yes	2.286 (0.843-6.197)	0.104	2.374 (0.792-7.109)	0.116
Only females				
Menopause				
No	1		1	
Yes	2.083 (0.716-6.062)	0.175	3.150 (0.921-10.770)	0.062
Pregnancy				
No	1		1	
Yes	0.522 (0.155-1.761)	0.290	1.196 (0.284-5.040)	0.808
Oophorectomy				
No	1		1	
Yes	1.656 (0.483-5.672)	0.420	1.095 (0.277-4.325)	0.897

[Table/Fig-3]: Association between low spinal bone mineral density and patients' characteristics.
a Reference group is patients with normal bone mineral density.
*Odds ratio; **Confidence interval; ***Standard deviation; ****Body mass index
+Logistic regression test was used to calculate p-value

Variables (mean±SD*)	Spinal bone mineral density measurement			p-value
	Normal	Osteopenia	Osteoporosis	
WBC[a] (1/μL)	7897.64±2150.84	8328.93±4052.51	7730.86±2805.29	0.63
RBC[b] (106/μ)	4.80±0.59	4.72±0.67	4.47±0.53	0.06
HCT[c] (%)	39.88±63.95	38.82±4.07	38.64±4.33	0.27
MCV[d] (fL)	81.81±5.81	80.55±6.63	77.86±11.42	0.06
MCH[e] (pg)	29.16±3.04	28.37±3.42	28.81±3.25	0.44
PLT[f] (1/μL)	226090.91±77405.44	225642.86±78194.26	202771.43±85125.19	0.32
FBS[g] (g/dL)	111.85±29.63	101.57±20.60	104.71±16.77	0.07
ESR[h] (mm/hr)	10.84±11.49	10.54±8.50	10.60±4.71	0.98
Vitamin D	24.45±14.55	22.13±14.11	14.51±12.79	0.004

[Table/Fig-4]: Association between low spinal bone mineral density and laboratory parameters.
* Standard Deviation
a) White blood cell; b) Red blood cell; c) Haematocrit; d) Mean corpuscular volume; e) Mean corpuscular haemoglobin; f) Platelet; g) Fasting blood sugar; h) Erythrocyte sedimentation rate
+ANOVA test was used to calculate p-value.

Variables	Femoral bone mineral density measurement			
	Osteopenia		Osteoporosis	
Males and females	OR*a (95% CI**)	p-value	ORa (95% CI)	p-value
Age (years-old, mean±SD*)**	1.076 (1.022-1.133)	0.006	1.311 (1.167-1.473)	<0.001
BMI** (Kg/m², mean±SD)**	0.866 (0.764-0.981)	0.024	0.959 (0.834-1.102)	0.551
Gender				
Male	1		1	
Female	2.072 (0.936-4.457)	0.061	3.391 (1.366-8.420)	0.007
Occupation				
Self-employment	1		1	
Homemaker	2.450 (1.117-5.373)	0.025	3.675 (1.476-9.146)	0.005
Employee	2.182 (0.336-14.152)	0.413	1.455 (0.120-17.654)	0.769
Residence				
Rural	1		1	
Urban	0.865 (0.387-1.933)	0.724	0.483 (0.201-1.164)	0.105
Smoking				
No	1		1	
Yes	0.811 (0.383-1.719)	0.585	0.587 (0.247-1.398)	0.229
Alcohol				
No	1		1	
Yes	0.455 (0.040-5.174)	0.516	1.500 (0.202-11.166)	0.691
Opioids				
No	1		1	
Yes	0.917 (0.334-2.518)	0.866	0.789 (0.241-2.581)	0.695
Anticonvulsants				
No	1		1	
Yes	1.942 (0.709-5.318)	0.197	2.891 (0.996-8.391)	0.051
Only females				
Menopause				
No	1		1	
Yes	0.912 (0.299-2.823)	0.883	0.875 (0.262-2.924)	0.828
Pregnancy				
No	1		1	
Yes	0.982 (0.300-3.216)	0.977	1.737 (0.426-7.087)	0.438
Oophorectomy				
No	1		1	
Yes	1.481 (0.438-5.015)	0.526	0.727 (0.171-3.093)	0.666

[Table/Fig-5]: Association between low femoral bone mineral density and patients' characteristics.
a Reference group is patients with normal bone mineral density.
*Odds ratio; **Confidence interval; ***Standard deviation; ****Body mass index
+Logistic regression test was used to calculate p-value

Hosseini SR et al., which was conducted on the elderly general population (>60-years-old) in our region Babol, showed that 34.5% of the subjects had osteoporosis which was somewhat higher than the prevalence of osteoporosis in this study. However, comparison of these results needs to be conducted with caution because of the differences in characteristics of the two populations [18]. This

Variables (mean±SD*)	Femoral bone mineral density measurement			p-value
	Normal	Osteopenia	Osteoporosis	
WBC[a] (1/μL)	7903.58±2493.22	8228.07±3883.56	7874.44±2714.75	0.82
RBC[b] (106/μ)	4.72±0.68	4.80±0.56	4.46±0.56	0.02
HCT[c] (%)	39.41±4.17	39.57±3.85	38.20±4.33	0.25
MCV[d] (fL)	81.11±6.21	80.81±6.35	78.61±11.46	0.29
MCH[e] (pg)	28.83±3.21	28.77±3.36	28.69±3.14	0.98
PLT[f] (1/μL)	242075.47±81813.30	206894.74±73785.32	209583.33±80704.17	0.04
FBS[g] (g/dL)	109.53±29.62	103.07±20.03	106.25±20.07	0.37
ESR[h] (mm/hr)	10.36±11.70	10.72±8.47	11.03±4.51	0.94
Vitamin D	26.40±14.87	21.05±13.37	13.69±12.14	<0.001

[Table/Fig-6]: Association between low femoral bone mineral density and laboratory parameters.
* Standard deviation
a) White blood cell; b) Red blood cell; c) Haematocrit; d) Mean corpuscular volume; e) Mean corpuscular haemoglobin; f) Platelet; g) Fasting blood sugar; h) Erythrocyte sedimentation rate
+ANOVA test was used to calculate p-value.

higher prevalence could result from physical inactivity in the aging people, which is associated with decreased bone mineral density. The previous reports stated that physical activity is positively involved in maintenance of bone mass through mechanical loading mechanisms [19].

Patients with symptomatic lumbar spinal stenosis experience back pain and neurogenic intermittent claudication that prevents them from doing daily activities, increase the risk of falling and result in progressive disability. Therefore, it is important to recognise the leading factors in the patients. Controlling and modifying these factors are helpful in better outcome of the disease [20,21]. Given the considerable prevalence of osteopenia and osteoporosis in the patients with lumbar spinal stenosis in our survey, it is suggested to screen such patients for low bone mineral density before surgical treatment, because surgery would be more difficult in them. For example, in laminectomy, screws would not efficiently hold the bone grafts inserted into the spine in the osteoporotic patients, and it is necessary to use more screws to provide spinal stability.

According to the results, age was correlated with increased risk of both osteopenia and osteoporosis, which was consistent with previously published data [22]. It was also stated that the prevalence rate of osteoporotic fracture increases with age, affecting the quality of life and increasing mortality rate [23].

Body mass index was associated with reduced risk of low bone mass in this study. There are conflicting results on this relationship; however, most of the results seem to be in favor of protective effect of higher BMI on bone mineral density and fragility fractures. Weight-related mechanical loading on bones is one of the accepted explanations of this association-that is, higher BMI induces a greater load [24,25].

This analysis showed no significant correlation between smoking and bone mineral density. Previous studies stated that smoking can probably cause significant bone loss and increase in risk of fracture, particularly in older people [26,27]. Also, smoking may prolong the healing process of fractures [28]. However, it is a modifiable risk factor. Nicotine is stated to possibly reduce the bone formation by osteoblasts and increase the osteoclastic resorption, through increased in secretion of tumour necrosis factor-α. Additionally, it has been noted that smoking may change the adrenal cortical hormone, leading to increase in bone resorption [29].

History of alcohol intake was not significantly associated with bone mineral density in the present study. The previous studies are mostly in agreement with negative effects of alcohol consumption on bone mass, especially in those with heavy intake of alcohol [30,31]. It can be explained by decrease in free testosterone and estradiol levels [29]. Testosterone was shown to stimulate production of osteoblasts and to decrease bone resorption, influencing positively the bone health [32]. On the other hand, some results showed that light or moderate level of alcohol intake can be modestly positive through prolonging the premenopausal period and elevating the serum-free testosterone after menopause [33,34].

As mentioned, no significant association was found between anticonvulsants and bone mass in our survey. A literature review by Lee RH et al., declared that there is a clinical converse association between use of anticonvulsant agents and bone mineral density [35]. It was also mentioned that anticonvulsant medications can increase the risk of fracture up to 2.4 times [35].

No associations existed between opioid use and bone mineral density in this research. Literature showed that use of opioid may lead to Opioid-Induced Androgen Deficiency (OPIAD). In this syndrome, gonadotropin releasing hormone is inhibited and consequently production of gender hormones, specifically testosterone, will decrease [36]. Therefore, it can be said that long-term use of opioid may result in osteoporosis.

As demonstrated above, females were at more risk of low bone mineral density compared with men. But, menopause was not found to be associated with osteoporosis among females. The evidence previously revealed the important role of estrogen in bone health in females. Thus, postmenopausal females who naturally experience estrogen deficiency tend to have low bone mass and fracture more than the premenopausal females [37,38]. Besides, as mentioned above, testosterone has a positive effect on bone health, therefore, being at higher risk of low bone mineral density is expected in females than in men.

Vitamin D had a significant positive correlation with bone mass in our survey, which was in harmony with previous reports [39,40]. Vitamin D has receptors in the small intestine contributing in absorption of intestinal calcium and phosphate [41]. Also, low level of 25-hydroxy vitamin D can cause secondary hyperparathyroidism and increase in bone turnover [42]. Hence, hypovitaminosis D can be an important risk factor for low bone mineral density.

We assessed the association between CBC parameters and bone mass in this study and witnessed significant relations between RBC and platelet counts and low bone mineral density. A study reported that white blood cells, RBC and platelet counts were positively correlated with T-scores [43]. Another research showed a relation between low bone mineral density and anaemia [44]. On the other hand, a recent survey found conflict correlations between mean platelet volume and bone mineral density [45]. It was expressed that osteoblastic cells are probably responsible

for regulating haematopoietic stem cells [43]. More studies need to be done to explain the linkage between bone metabolism and haematopoiesis.

Oophorectomy was not significantly associated with bone mass in our survey. A study showed that rate of bone loss was slower in females retained ovaries compared with those who underwent oophorectomy [46]. This can be explained by the fact that females with oophorectomy are deprived of estrogen.

In the present study, no significant association was found between pregnancy and low bone mineral density. During pregnancy and lactation, calcium demand and bone resorption increases which can develop osteoporosis in females. However, pregnancy-related osteoporosis is stated to be a very rare condition [47,48]. Limited data is available on the relation between pregnancy and low bone mineral density and more studies are needed to clarify it.

LIMITATION

A limitation of our study was that no control group of subjects without lumbar canal stenosis was used to assess the association between lumbar stenosis and bone mineral density. So, it is suggested to perform a case-control study on this topic in the future.

CONCLUSION

According to the results of this audit, the prevalence of low bone mineral density was considerable in patients with lumbar spinal stenosis. Also, being a female, higher age, lower body mass index and being a homemaker were found as risk factors for low bone mineral density. There were also associations between bone mass and red blood cell and platelet counts and vitamin D. Early screening of the patients with lumbar stenosis for osteoporosis and control of the modifiable factors (e.g., hypovitaminosis D) can help in the prevention of spinal complications, improvement of patients' physical activity, and surgical treatment outcome.

ACKNOWLEDGEMENTS

We would like to thank the Vice Chancellor for Research and Technology of Babol University of Medical Sciences for supporting our project. We are also thankful to the staff of Clinical Research Development Center of Shahid Beheshti hospital for their cooperation.

REFERENCES

[1] Park SB, Chung CK. Strategies of spinal fusion on osteoporotic spine. J Korean Neurosurg Soc. 2011;49(6):317-22.
[2] Genevay S, Atlas SJ. Lumbar Spinal Stenosis. Best Pract Res Clin Rheumatol. 2010;24(2):253-65.
[3] Rainville J, Lopez E. Comparison of radicular symptoms caused by lumbar disc herniation and lumbar spinal stenosis in the elderly. Spine. 2013;38(15):1282-87.
[4] Lurie J, Tomkins-Lane C. Management of lumbar spinal stenosis. BMJ: British Medical Journal (Online). 2016;352:h6234.
[5] Kovacs FM, Urrútia G, Alarcón JD. Surgery versus conservative treatment for symptomatic lumbar spinal stenosis: a systematic review of randomized controlled trials. Spine. 2011;36(20):E1335-E51.
[6] Maeda T, Hashizume H, Yoshimura N, Oka H, Ishimoto Y, Nagata K, et al. Factors associated with lumbar spinal stenosis in a large-scale, population-based cohort: The Wakayama Spine Study. PLoS ONE. 2018;13(7):e0200208.
[7] Naylor A. Factors in the development of the spinal stenosis syndrome. The Journal of Bone and Joint Surgery British volume. 1979;61(3):306-09.
[8] Siebert E, Prüss H, Klingebiel R, Failli V, Einhäupl KM, Schwab JM. Lumbar spinal stenosis: syndrome, diagnostics and treatment. Nature Reviews Neurology. 2009;5(7):392.
[9] Tomé-Bermejo F, Piñera AR, Alvarez-Galovich L. Osteoporosis and the management of spinal degenerative disease (I). Arch Bone Jt Surg. 2017;5(5):272-82.
[10] Andersen T, Christensen FB, Langdahl BL, Ernst C, Fruensgaard S, Østergaard J, et al. Degenerative spondylolisthesis is associated with low spinal bone density: a comparative study between spinal stenosis and degenerative spondylolisthesis. Biomed Res Int. 2013;2013:123847.
[11] Ji MX, Yu Q. Primary osteoporosis in postmenopausal women. Chronic Dis Transl Med. 2015;1(1):9-13.
[12] Chitten JJ, James B. Prevalence of osteopenia and osteoporosis in orthopaedic outpatients in southern India. J Clin Diagn Res. 2018;12(3):RC14-RC7.
[13] Kim HJ, Lee HM, Kim HS, Park JO, Moon ES, Park H, et al. Bone metabolism in postmenopausal women with lumbar spinal stenosis: analysis of bone mineral density and bone turnover markers. Spine (Phila Pa 1976). 2008;33(22):2435-39.
[14] Lee BH, Moon SH, Kim HJ, Lee HM, Kim TH. Osteoporotic profiles in elderly patients with symptomatic lumbar spinal canal stenosis. Indian J Orthop. 2012;46(3):279-84.
[15] Verbiest H. The significance and principles of computerized axial tomography in idiopathic developmental stenosis of the bony lumbar vertebral canal. Spine (Phila Pa 1976). 1979;4(4):369-78.
[16] World Health Organization. Prevention and management of osteoporosis. Geneva: WHO; 2003.
[17] 2015 ISCD Official Positions-Adult. https://www.iscd.org/official-positions/2015-iscd-official-positions-adult/.
[18] Hosseini SR, Baghitabar N, Mirzapour A, Oliaei F, Nooreddini H, Bijani A, et al. Hyponatremia, bone mineral density and falls in the elderly; Results from AHAP study. Rom J Intern Med. 2018;56(1):41-46.
[19] Alghadir AH, Gabr SA, Al-Eisa E. Physical activity and lifestyle effects on bone mineral density among young adults: sociodemographic and biochemical analysis. J Phys Ther Sci. 2015;27(7):2261-70.
[20] Lee SY, Kim TH, Oh JK, Lee SJ, Park MS. Lumbar stenosis: a recent update by review of literature. Asian Spine J. 2015;9(5):818-28.
[21] Ammendolia C, Stuber K, de Bruin LK, Furlan AD, Kennedy CA, Rampersaud YR, et al. Nonoperative treatment of lumbar spinal stenosis with neurogenic claudication: a systematic review. Spine (Phila Pa 1976). 2012;37(10):E609-E16.
[22] Demontiero O, Vidal C, Duque G. Aging and bone loss: new insights for the clinician. Ther Adv Musculoskelet Dis. 2012;4(2):61-76.
[23] Johnell O, Kanis J. Epidemiology of osteoporotic fractures. Osteoporos Int. 2005;16(2):S3-S7.
[24] Xiang BY, Huang W, Zhou GQ, Hu N, Chen H, Chen C. Body mass index and the risk of low bone mass-related fractures in women compared with men: A PRISMA-compliant meta-analysis of prospective cohort studies. Medicine (Baltimore). 2017;96(12):e5290.
[25] Rexhepi S, Bahtiri E, Rexhepi M, Sahatciu-Meka V, Rexhepi B. Association of body weight and body mass index with bone mineral density in women and men from Kosovo. Mater Sociomed. 2015;27(4):259-62.
[26] Brook JS, Balka EB, Zhang C. The smoking patterns of women in their forties: their relationship to later osteoporosis. Psychol Rep. 2012;110(2):351-62.
[27] Ayo-Yusuf O, Olutola B. Epidemiological association between osteoporosis and combined smoking and use of snuff among South African women. Niger J Clin Pract. 2014;17(2):174-77.
[28] NIH Osteoporosis and Related Bone Diseases-National Resource Center. Smoking and Bone Health. United States of America; 2016. Available from: https://www.bones.nih.gov/health-info/bone/osteoporosis/conditions-behaviors/bone-smoking.
[29] Abrahamsen B, Brask-Lindemann D, Rubin KH, Schwarz P. A review of lifestyle, smoking and other modifiable risk factors for osteoporotic fractures. Bonekey Rep. 2014;3:574.
[30] Cho Y, Choi S, Kim K, Lee G, Park SM. Association between alcohol consumption and bone mineral density in elderly Korean men and women. Arch Osteoporos. 2018;13(1):46.
[31] Jang HD, Hong JY, Han K, Lee JC, Shin B-J, Choi S-W, et al. Relationship between bone mineral density and alcohol intake: A nationwide health survey analysis of postmenopausal women. PLoS One. 2017;12(6):e0180132.
[32] Mohamad NV, Soelaiman IN, Chin KY. A concise review of testosterone and bone health. Clin Interv Aging. 2016;11:1317-24.
[33] Sapre S, Thakur R. Lifestyle and dietary factors determine age at natural menopause. J Midlife Health. 2014;5(1):3-5.
[34] Rinaldi S, Peeters P, Bezemer I, Dossus L, Biessy C, Sacerdote C, et al. Relationship of alcohol intake and sex steroid concentrations in blood in pre-and post-menopausal women: the European Prospective Investigation into Cancer and Nutrition. Cancer Causes Control. 2006;17(8):1033-43.
[35] Lee RH, Lyles KW, Colón-Emeric C. A Review of the Effect of Anticonvulsant Medications on Bone Mineral Density and Fracture Risk. Am J Geriatr Pharmacother. 2010;8(1):34-46.
[36] Smith HS, Elliott JA. Opioid-Induced Androgen Deficiency (OPIAD). Pain physician. 2012;15(3 Suppl):ES145-56.
[37] Alswat KA. Gender Disparities in Osteoporosis. J Clin Med Res. 2017;9(5):382-87.
[38] Saha MM, Biswas S, Bhadra B. An observational study to evaluate the changes in bone mineral density of women with aging in a tertiary care centre. J Clin Diagn Res. 2018;12(7):QC13-QC5.
[39] Modagan P, Silambanan S, Menon G, Arunalatha P. Serum 25-hydroxy Vitamin D levels as an indicator of bone mineral density in osteoporosis. J Clin Diagn Res. 2018;12(8):BC19-BC21.
[40] Brincat M, Gambin J, Brincat M, Calleja-Agius J. The role of vitamin D in osteoporosis. Maturitas. 2015;80(3):329-32.
[41] Ubesie AC, Heubi JE, Kocoshis SA, Henderson CJ, Mezoff AG, Rao MB, et al. Vitamin D deficiency and low bone mineral density in pediatric and young adult intestinal failure. J Pediatr Gastroenterol Nutr. 2013;57(3):372-76.
[42] Sadat-Ali M, Al Elq AH, Al-Turki HA, Al-Mulhim FA, Al-Ali AK. Influence of vitamin D levels on bone mineral density and osteoporosis. Ann Saudi Med. 2011;31(6):602-08.

[43] Kim HL, Cho HY, Park IY, Choi JM, Kim M, Jang HJ, et al. The positive association between peripheral blood cell counts and bone mineral density in postmenopausal women. Yonsei Med J. 2011;52(5):739-45.
[44] Valderrábano RJ, Lui LY, Lee J, Cummings SR, Orwoll ES, Hoffman AR, et al. Bone density loss is associated with blood cell counts. J Bone Miner Res. 2017;32(2):212-20.
[45] Aypak C, Türedi Ö, Bircan MA, Civelek GM, Araz M. Association between mean platelet volume and bone mineral density in postmenopausal women. J Phys Ther Sci. 2016;28(6):1753-58.
[46] Mucowski SJ, Mack WJ, Shoupe D, Kono N, Paulson R, Hodis HN. The effect of prior oophorectomy on changes in bone mineral density and carotid artery intima-media thickness in postmenopausal women. Fertil Steril. 2014;101(4):1117-22.
[47] Yun KY, Han SE, Kim SC, Joo JK, Lee KS. Pregnancy-related osteoporosis and spinal fractures. Obstet Gynecol Sci. 2017;60(1):133-37.
[48] Salari P, Abdollahi M. The influence of pregnancy and lactation on maternal bone health: a systematic review. J Family Reprod Health. 2014;8(4):135-48.

PARTICULARS OF CONTRIBUTORS:
1. Postgraduate Student, Student Research Committee, Babol University of Medical Sciences, Babol, Mazandaran, Iran.
2. Assistant Professor, Department of Orthopaedics, Babol University of Medical Sciences, Babol, Mazandaran, Iran.
3. Associate Professor, Clinical Research Development Center, Shahid Beheshti Hospital, Babol University of Medical Sciences, Babol, Mazandaran, Iran.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Seyed Mokhtar Esmaeilnejad-Ganji,
Department of Orthopaedics, Babol University of Medical Sciences, Ganjafrooz Street, Babol, Mazandaran, Iran.
E-mail: smsnganji@yahoo.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Sep 19, 2018**
Date of Peer Review: **Nov 01, 2018**
Date of Acceptance: **Nov 14, 2018**
Date of Publishing: **Feb 01, 2019**