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Serum Vitamin D Level and Bone Mineral Density Among Adolescent Idiopathic Scoliotic Patients

Rheumatology And Rehabilitation

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ABSTRACT

Background: Low bone mineral density (BMD) and hypovitaminosis D were found to be associated in adolescent idiopathic scoliosis (AIS) patients. The incidence of AIS with osteoporosis is believed to reduce the intensity of the bone by about 20-38 percent.
Aim of The Work: To assess serum vitamin D level and BMD in patients with adolescent scoliosis.
Patients and Methods: This work involved 112 patients diagnosed with AIS and a Cobb angle > 10o aged from 10 - 18 years old. Vitamin D level, Cobb angle and BMD measured in all subjects.
Results: Our result included 112 patients, seventy-four (66.1%) of the patients had vitamin D deficiency. Osteopenia present in 39% and osteoporosis in 25% of AIS patients by lumbar spine Z-score and by hip Z-score, osteopenia present in 53% and osteoporosis in 12% of AIS patients.
Conclusion: Study concluded that majority of AIS patients have low serum vitamin D level and low BMD.

Keywords: *Adolescent idiopathic scoliosis; bone mineral density; vitamin D.*

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INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is the commonest type of pediatric scoliosis with prevalence about 1% to 3% [1]. It takes place in persons from 10 to 18 years of age. Typically, idiopathic scoliosis means an unexplained etiology of a particular syndrome, congenital and neuromuscular disorder [2].

Etiology of AIS may involve Genetic and non-genetic causes [3]. Bone mineral density (BMD) is one of the non-genetic causes, as bone content plays a vital role in distorting osseous mechanical strength. The incidence of AIS with osteoporosis is believed to reduce the intensity of the bone by about 20-38 percent [4].

Vitamin D has a vital role in preserving a good, mineralized bone. It aids in the absorption of calcium and vitamin D-deficient patients may have problems in developing new bones and retaining bone intensity [5].

Many recent researches have indicated that the start and development of AIS could be caused by a decline in BMD, and some researches have attempted to correlate vitamin D with AIS [6]. Considering that serum vitamin D level has a positive correlation with the BMD of the hip [7,8] and negative correlation with the Cobb angle [9] , vitamin D insufficiency or deficiency is speculated to has effects on AIS etiopathogenesis Exploration of vitamin D associations with AIS can help us understand spinal deformity pathogenesis in the AIS [10]. The purpose of this research is to measure vitamin D and BMD in adolescent scoliosis.

PATIENTS AND METHODS

A prospective, non-interventional study for 112 subjects diagnosed with idiopathic scoliosis and a Cobb angle > 10^o aged from 10 - 18 years old had been recruited from Al-Azhar University hospitals during the period from 1 March 2020 to 1 March 2021.

Our study was approved by a local ethical committee. A written informed consent was achieved from the parents of all the participants.

Exclusion criteria:

Age less than 10 or more than 18 years.
Causes of secondary scoliosis (congenital, neuromuscular, or traumatic).
Postural scoliosis, metabolic or endocrine diseases.
Patients with fracture history.

Methods:

All participants subjected to full history, examination, serum vitamin D, Cobb angle, Beighton scale for Joint hypermobility [11], spinal and bilateral femoral neck BMD, trabecular bone score (TBS), serum calcium, phosphorus, parathyroid hormone, and alkaline phosphatase (ALP).

Serum 25-hydroxyvitamin D (25(OH)D) were assessed using electrochemiluminescence immunoassay (Roche, USA). Regarding to the producer, normal 25(OH)D is ≥75 nmol/L and low levels are < 75 nmol/L. Cobb angle was achieved by estimating the largest spinal curve, taken from the upper-end vertebra until the lower-end vertebra, on x-ray. BMD of the lumbar spine (L1–L4) and the proximal femur (neck, Ward's triangle, and greater trochanter) were assessed by dual-energy X-ray absorptiometry (DEXA; Hologic, Discovery, QDR series, GE Medical, Milwaukee, WI, USA).

Statistical analysis:

The Statistical package for Social Science (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) was used. The Mean and standard deviation (mean ± SD) were used to describe the parametric numerical data. The frequency and percentage were used to describe the non-numerical data. Pearson's correlation test was used to determine the correlation between 25(OH)D and the other study variables.

RESULTS

A total of 112 participants, their mean of age 15.81 years and BMI mean was 19.63 kg/m^2. The majority of patients was females (63.4%). Seventy-four (66.1%) of our patients had vitamin D deficiency. The mean Cobb angle was 24.63° (table 1).

Considering bone density, mean of femoral neck BMD 0.73 g/cm^2, greater trochanter BMD 0.64 g/cm^2, ward's triangle BMD 0.63 g/cm^2 and lumbar spine BMD 0.82 g/cm^2. Mean of trabecular bone score was 0.99. Also, mean of beighton scale was 5.33. Mean of lumbar and hip Z-score was -1.531 and -1.362 (table 2). Osteopenia present in 39% and osteoporosis in 25% of AIS patients by lumbar spine Z-score and by hip Z-score, osteopenia present in 53% and osteoporosis in 12% of AIS patients (Figure 1).

Regarding to laboratory results, mean of 25-OH-D3 was 15.30 ng/ml, ca 5.92 mg/dl, phosphorus 4.32 mg/dl, ALP 170 IU/L and PTH 47.90 pg/ml (table 3).

There is negative significant association between 25(OH)D and cobb angel (p value < 0.001) and positive significant association between 25(OH)D, calcium and BMD of hip (p value= 0.001 and 0.019, respectively) while no significant correlation was found between 25(OH) D and BMD of lumbar spine (table 4).

	Cases (n= 112)	
	Mean / No	**SD / %**
Age (year)	15.81	12.13
BMI (kg/m^2)	19.63	1.51
Sex		
- Male	41	36.6%
- Female	71	63.4%
Cobb angle (°)	24.63	3.13
Vitamin D Insufficiency	74	66.1%

Table 1: Distribution of patients regarding demographic and clinical data

	Cases (n= 112)	
	Mean	**SD**
BMD of hip (g/cm^2)		
- Femoral neck	0.73	0.12
- Greater trochanter	0.64	0.92
- Ward's triangle	0.63	0.11
BMD of lumbar spine (g/cm^2)	0.82	0.14
Z- score		
- Spine	–1.531	-0.4
- Hip	–1.362	-0.5
TBS	1.21	0.14
Beighton scale	5.33	1.33

TBS: trabecular bone score

Table 2: Distribution of studied patients regarding bone density investigation

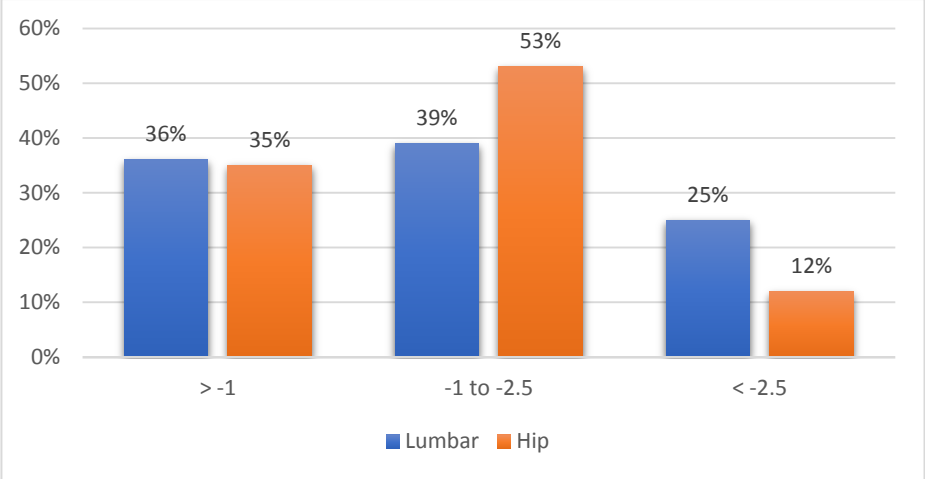


Fig. 1: Z-score of the hip and lumbar spine of studied patients

	Cases (n= 112)	
	Mean	**SD**
25-OH-D3 (ng/mL)	15.30	5.57
Ca $^{2+}$ (mg/dl)	5.92	1.35
Phosphorus (mg/dl)	4.32	0.38
ALP (IU/L)	170.89	79.55
PTH (pg/mL)	47.90	12.45

ALP: Alkaline phosphatase, PTH: parathyroid hormone

Table 3: Distribution of studied patients regarding laboratory investigation

	25-OH-D3	
	r	*p*
Cobb angle (°)	-0.461	**< 0.001***
Ca	0.663	**0.001***
BMD of hip	0.411	**0.019***
BMD of lumbar spine	0.173	0.281

Pearson's correlation test. *p value is significant

Table 4: Correlation between 25-OH-D3 and cobb angle, calcium, and BMD.

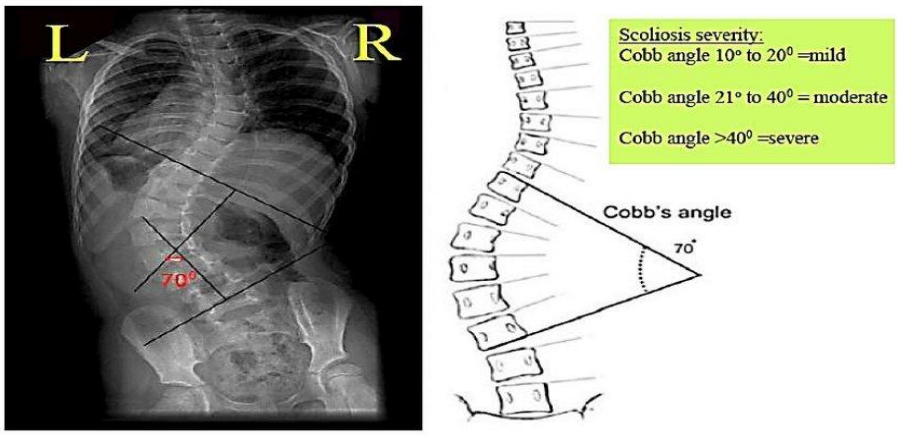
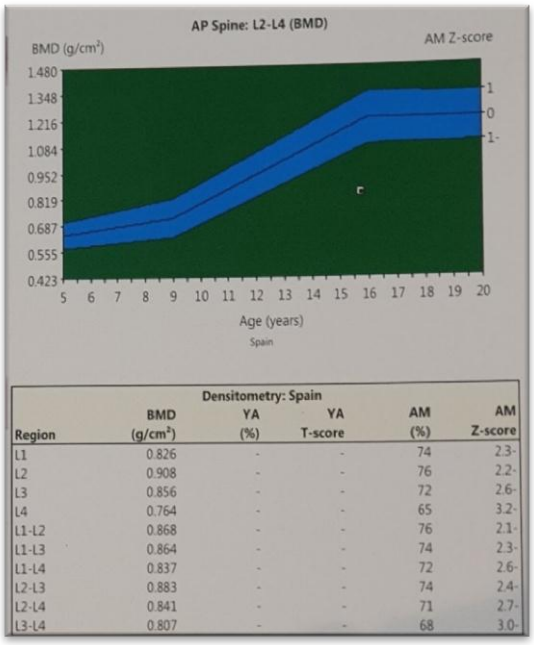


Fig. 2: Measurement of Cobb angle. (12)



Densitometry: Spain

Region	BMD (g/cm²)	YA (%)	YA T-score	AM (%)	AM Z-score
L1	0.826	-	-	74	2.3-
L2	0.908	-	-	76	2.2-
L3	0.856	-	-	72	2.6-
L4	0.764	-	-	65	3.2-
L1-L2	0.868	-	-	76	2.1-
L1-L3	0.864	-	-	74	2.3-
L1-L4	0.837	-	-	72	2.6-
L2-L3	0.883	-	-	74	2.4-
L2-L4	0.841	-	-	71	2.7-
L3-L4	0.807	-	-	68	3.0-

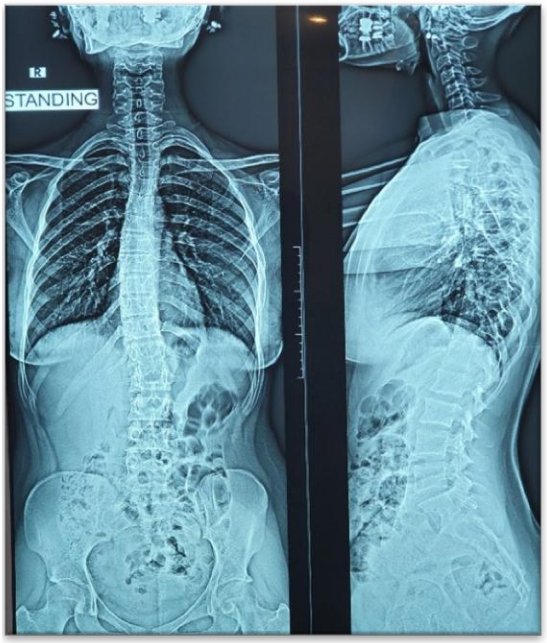


Fig. 3: Plain X-ray whole spine A-P and lateral view in standing position (Cobs Angle 19.8). and DEXA imaging of the same patient showing Z-score at L1-4 -2.6.

DISCUSSION

Inadequate levels of Vitamin D in adolescents can occur for different causes, like lower sun exposure, exercise and inadequate vitamin D diet [13]. In our work, all participants were asked whether vitamin D, ca or any vitamins were used, and in all cases the response was no.

The optimum vitamin D value, estimated by 25-OH-Vitamin D, was suggested at a level above 30 ng/ml, with a normal level between 40 and 60 ng/ml. Deficiency is determined when the value is below 20 ng/ml, and between 20 and 29 ng/ml, the patient is defined to have an insufficient value [14].

Some studies have revealed that vitamin D levels are smaller than those of a control group in adolescent idiopathic scoliosis [15,16].

The inception and progression of AIS is thought to be linked with vitamin D. The finding of current study revealed that 25-OH-vit D was low in 74 (66.1%) patients. Our finding supported by other authors [17-19], who reported that 25-OH-vit D was lower in patients with AIS comparing with a control group.

In patients with AIS, some reports have identified the low BMD and spinal deformation correlation. The reasons for osteoporosis or osteopenia are still unclear in AIS patients and even low bone density was primary or secondary cause still unknown [20].

Osteoporosis is considered as Z-score < –2.5 while osteopenia is considered as a Z-score from -1 to -2.5. Prevalence of osteopenia in AIS has been reported to be about 30 % [21]. The low BMD in AIS subjects could be due to unusual bone mineralization and therefore do not diagnosed in the peripubertal cycle due to accelerated bone growth [22] .

Our results revealed that osteopenia present in 39% and osteoporosis in 25% of AIS cases by lumbar spine Z-score. This in line with A meta-analysis of 3 researches of 686 AIS patients. It reported that osteopenia was found in 51.1% of cases [23].

However, A recent study of Almomen et al. [24] reported a higher incidence of low bone mass (62.9% and 74.1% for lumbar and femoral BMD, respectively). This may be due to their study involved AIS patients with Cobb angles $\geq 40^{o}$.

CONCLUSION

We found that the majority of AIS patients have low serum vitamin D values. In addition, majority of AIS patients have low BMD.

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