Prospective study of the correlation between bone mass density and vitamin D levels

Poster No.: C-2145
Congress: ECR 2018
Type: Scientific Exhibit
Authors: N. Goyal1, S. D. Khanpara2, K. S. Rathod3, N. Bahri4; 1New Delhi/IN, 2Jamnagar, Gu/IN, 3Jamnagar/IN, 4JAMNAGAR, GUJARAT/IN
Keywords: Musculoskeletal spine, Radioprotection / Radiation dose, Education, Osteoporosis, Absorptiometry / Bone densitometry
DOI: 10.1594/ecr2018/C-2145

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Aims and objectives

Osteoporosis has been defined as 'low bone mass and micro-architectural deterioration of bone tissue leading to enhanced bone fragility and consequent increase in fracture' by the World Health Organization[1].

It is a silent epidemic and has been termed as the silent thief, producing no symptoms until a fragility fracture occurs. [1]

Although osteoporosis creates health problems mainly in elderly, the process largely begins at a younger age. Bone mass and bone density increase the most during childhood and adolescence in both sexes, and usually peak bone mass is maximized by the age of 30. Therefore, young adults are a targeted group for osteoporosis prevention[2].

If young adults maximize their bone density, they can prevent or delay the development and severity of osteoporosis. Thus, the potential public burden of osteoporotic fractures can be reduced[3].

Early detection is a key to intervention. Dual energy X-ray Absorptiometry (DEXA) is the most widely accepted method for the quantitative assessment of bone mineral status and is currently the standard of reference for the clinical diagnosis of osteoporosis with bone densitometry.[4,5,6]

Normal bone metabolism depends on the presence of appropriate repletion of vitamin D. Vitamin D insufficiency occurs commonly in many parts. [7]

The importance of vitamin D insufficiency is related primarily to bone integrity. Determination of serum 25 hydroxyvitamin D [25(OH)D] is the most clinically reliable indicator of vitamin D status. Thus, low serum 25(OH) D concentration is associated with secondary hyperparathyroidism, increased bone turnover, reduced Bone mass density [BMD], and increased risk of osteoporotic fractures [8-12]. In addition, administration of vitamin D slows bone turnover, increases BMD, and can reduce the rates of fragility fractures.

Therefore, purpose of this study was to study correlation between between bone mass density and Vitamin D levels among young adults. Also, to study effect on bone mass density after Vitamin D supplementation.
Methods and materials

Study Population

A prospective study was done on 50 volunteer resident doctors at Shree M.P.Shah Government Medical College, Jamnagar, Gujarat, India from July 2014 to June 2015 after approval from institutional ethical board.

Analysis of Bone mass density (BMD).

As, World Health Organization (WHO), has defined osteoporosis based on Bone mass density (BMD) measurements in standard deviation (SD) units called T-scores [1].

BMD was thus, analyzed by measuring T-scores of lumbar spine by means of Dual-Energy X-Ray Absorptiometry using Lunar DPX DXA System (analysis version: 12.30).

The T-score is the difference between a patient's measured BMD and the mean BMD of healthy, young-adults matched for gender and ethnic group, hence, indicates the difference between the patient's BMD and the ideal peak bone mass achieved by a young-adult. T-score # -1 is considered normal.

Osteoporosis is defined as T-score # -2.5.

Osteopenia is defined by a T-score between -2.5 and -1.

Analysis of Vitamin D levels.

Serum 25, hydroxyl VITAMIN D levels were analyzed by electrochemiluminesance using automated immunoassay system "COBAS e-411".

To assess Vitamin D levels, **US Endocrine Society classification was followed**:

<table>
<thead>
<tr>
<th>Vitamin D concentration</th>
<th>Vitamin D levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20 ng/mL</td>
<td>Deficiency</td>
</tr>
<tr>
<td>21-29 ng/mL</td>
<td>Insufficiency</td>
</tr>
<tr>
<td>&gt;30 ng/mL</td>
<td>Sufficiency</td>
</tr>
</tbody>
</table>

Vitamin D supplementation
The volunteers with decreased BMD were provided 60,000IU Cholecalciferol chewable tablets per week for 4 weeks.

After 6 months of supplementation the Vitamin D levels and bone density of the volunteers were reassessed, by the same method as before.

**Inclusion criteria** for study included volunteering resident doctors of <35 years age.

**Exclusion criteria** comprised of, past history of vertebral fracture, history of metabolic disease, nephrolithiasis, urolithiasis and pregnancy.
Results

BEFORE VITAMIN D SUPPLEMENTATION

BONE MASS DENSITY

- Among 50 volunteers (male: female:: 3:2) 60% had decreased BMD 18% were osteoporotic and 42% were osteopenic (Fig 1)
- Of 30 male candidates 14(47%) had normal bone mass density, 10(33%) had osteopenia, and the rest 6(20%) had osteoporosis.
- Out of 20 female candidates 6(30%) had normal bone mass density, 11(55%) had osteopenia, and the rest 3(15%) had osteoporosis (Fig 2)

VITAMIN D LEVELS

- Of 50 candidates, 48 (96%) volunteers who were Vitamin D deficiency (Fig 3)
- out of them 26 (54%) had severe Vitamin D deficiency, 14(29%) had moderate Vitamin D deficiency and rest, 8 (17%) had mild Vitamin D deficiency (Fig 4)
- Also, of the 48 individuals with deficient Vitamin D levels 8(16%) were osteoporotic, 20 (42%) were osteopenic and the rest 20 (42%) had normal bone mass density. (Fig 5)
- There was no statistically significant correlation between Vitamin D levels and bone mass density evaluated by T score. (Fig 6)

AFTER VITAMIN D SUPPLEMENTATION

- After 6 months of Vitamin D supplementation, candidates with normal BMD increased from 0 to 11( 38%), osteopenia reduced from 21(73%) to 17 (58%), osteoporosis decreased from 8(27%) to 1 (3%). (Fig 7)
- Furthermore, severe Vitamin D deficiency reduced from 12(46%) to 1( 4%).
- There was statistically significant linear correlation between Vitamin D levels and T score, after Vitamin D supplementation and also between increase in Vitamin D levels with change in T score. (Fig 8,9)
- Pearson Correlation Coefficient was used to measures the strength of the linear relationship between change in T score and Vitamin D levels before and after vitamin D supplementation, using Excel CORREL function. Pearson product moment correlation coefficient, r. Before supplementation -0.155596533 after supplementation 0.268749478
Fig. 1: Bone mass density of all volunteers

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Fig. 2: Comparison of BMD between males and females.

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Fig. 3: Vitamin D levels in all volunteers

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<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Vitamin D</th>
<th>No of volunteers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Severe (&lt;5ng/mL)</td>
<td>26</td>
</tr>
<tr>
<td>2.</td>
<td>Moderate (5-9.9 ng/mL)</td>
<td>14</td>
</tr>
<tr>
<td>3.</td>
<td>Mild (10-20ng/mL)</td>
<td>8</td>
</tr>
</tbody>
</table>

Fig. 4: Distribution of Vitamin D deficiency

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Fig. 5: Correlation between Vitamin D levels and bone mass density

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**Fig. 6:** Scatter diagram showing no significant correlation between T score and Vitamin D levels.

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Fig. 7: Correlation of BMD before and after Vitamin D supplementation

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**Fig. 8:** Line graph showing increase in bone mass density after Vitamin D supplementation

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Fig. 9: Scatter diagram showing positive correlation between T score and Vitamin D levels after Vitamin D supplementation

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**Fig. 10:** Change in BMD after Vitamin D supplementation

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Conclusion

- The study concluded that decreased BMD is highly prevalent even among young adults.
- Few of the candidates with vitamin D deficiency had normal bone mass density, insinuating that there are factors other than Vitamin D which play a role in bone mass density.
- Vitamin D supplementation increases bone mass density, hence is an essential element in prevention of osteoporosis.
1. Integrated Imaging Approach to Osteoporosis: State-of-the-Art Review and Update. Giuseppe Guglielmi, MD, Silvana Muscarella, MD, and Alberto Bazzocchi, MD. From the Department of Radiology, University of Foggia, Viale L. Pinto 1, 71100 Foggia, Italy (G.G.); Department of Radiology, Scientific Institute.


6. Dual Energy X-ray Absorptiometry for Bone Mineral Density and Bone Composition Assesment. JAEA Humal HEALTH Series No. 15.


