The study of correlation of Vitamin D level with severity of osteoporosis and evaluation of effect of Vitamin D supplementation in treatment of osteoporosis in elderly Indian patient population

Panna Mishra¹, Vikas Trivedi², Ankur Goel², Karn Singh Chauhan²

Abstract

Introduction: Osteoporosis is defined as a disease characterized by low bone mass and micro-architectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk especially in elderly. The association between vitamin D deficiency and osteoporosis and impact of vitamin D deficiency on treatment of osteoporosis is rarely studied in detail in Indian population. The present study was planned to find out correlation between vitamin D levels and osteoporosis severity and to evaluate the role of vitamin D supplementation in the treatment of osteoporosis in Indian population.

Material & Methods: This is a randomized controlled study of total 80 patients with osteoporosis and Vitamin D levels < 20ng/ml were randomly allocated to one of the two groups as follows: Study Group I (n=40): In this group apart from usual treatment of osteoporosis which include ibandronic acid 150mg once a month for 6 months along with calcium (500mg), the patients were given 60,000 IU of vitamin D once weekly for 6 months in oral nano solution form. Placebo Group II (n=40): In this group no additional Vitamin D supplementation was given, rest of the anti osteoporotic treatment was same as Group I. The patients were followed up at 3 months, 6 months and at 1 year period with Bone mineral Density (BMD) and serum vitamin D levels evaluated at each follow up visit. BMD evaluation was done by Dual Energy X-ray Absorptiometry (DEXA). A T-score was used for evaluation of BMD. T-score shows how much your bone density is higher or lower than the bone density of a healthy 30-year old adult. According to the World Health Organization (WHO), a T-score of -1.0 or above is normal bone density, a T-score between -1.0 and -2.5 means you have low bone density or osteopenia. A T-score of -2.5 or below is a diagnosis of osteoporosis. The lower a person’s T-score, the lower the bone density. The data was analyzed using Statistical Package for Social Sciences version 15.0. Proportional data were compared using chi-square test whereas mean differences were compared using Student “t”-test. Within group change were studied using paired ‘t’-test. The confidence level of the study is kept at 95%, hence a “p” value less than 0.05 were considered significant.

Results: Age of patients ranged from 60 to 78 years. Maximum number of patients were of 66-70 years (41.3%). Majority of patients were females (n=51; 63.7%). Female to male ratio was 1.75:1. At baseline, mean T-score values were -2.93±0.24 in Group I and -2.89±0.19 in Group II. At baseline, mean vitamin D levels were 12.55±2.35 ng/ml and 11.88±2.39 ng/ml respectively in Groups I and II. At 6 months, mean T-score values were -1.47±1.27 in Group I and -2.30±0.67 in Group II. On evaluating the data statistically, the difference between two groups was found to be significant (p<0.001). The mean vitamin D levels were 26.44±7.25 ng/ml and 13.58±2.26 ng/ml respectively in Groups I and II. At 1 year, mean T-score values were -1.47±1.27 in Group I and -2.30±0.67 in Group II. On evaluating the data statistically, the difference between two groups was found to be significant (p<0.001).

Conclusion: This study concludes that appropriate supplementation of vitamin D helps in speedy improvement of BMD in osteoporosis patients. It is also shown that vitamin D oral supplementation also helped to improvise as well as normalize the vitamin D status among elderly. Hence it is suggested through this study that vitamin D supplementation is highly recommended in elderly to treat the osteoporosis.

Keywords: Osteoporosis, Vitamin D, Bone Mineral Density, T-score, Fractures.

Introduction

Osteoporosis is defined as a disease characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk [1]. Clinically, bone strength is estimated by non-invasive assessment of bone mineral density (BMD) by dual-energy X-ray absorptiometry (DEXA). As endorsed by the World Health Organization (WHO), the clinical diagnosis of osteoporosis is based on BMD measurements and the presence of fractures [2]. For these diagnostic criteria, BMD is
transformed into a T-score, which reflects the number of standard deviations (SD) above or below the mean in healthy young adults. (Table 1)

With advancing age, BMD decreases and prevalence of osteoporosis increases. In the United States, Europe and Japan, osteoporosis affects about 75 million people [2]. Using the WHO criteria, 30% of postmenopausal Caucasian women have osteoporosis at the hip, lumbar spine or distal forearm [3]. By the age of 80 years, 70% of women are osteoporotic at the hip, lumbar spine or distal forearm [3]. The belief that osteoporosis is prevalent in the West and rare in the East is a myth. In Indian population, the prevalence of osteoporosis in elderly men and women has been reported to be 11.1% and 24.1% respectively [4].

Osteoporosis to a large extent is attributable to vitamin D deficiency, especially in Asians and Indians, the widespread vitamin D deficiency across India, at all ages and in both sexes has been attributed to be the reason for increasing rate of osteoporosis [5]. Recent evidence has indicated that vitamin D deficiency is related with osteoporosis and vitamin D has a preventive effect on osteoporosis [6-8]. Moreover, it is established that elderly people in general have vitamin D deficiency [9], thus rationalizing the high age-associated increasing risk of osteoporosis in elderly.

Understanding this relationship between age, vitamin D levels and osteoporosis, clinical trials have indicated that vitamin D supplementation might have a positive impact on reversal of osteoporosis and improvement in overall quality of life of elderly people [10, 11].

Keeping these associations in mind, the present study was planned to find out correlation between vitamin D levels and osteoporosis severity and to evaluate the role of vitamin D supplementation in the treatment of osteoporosis.

The association between vitamin D deficiency and osteoporosis and impact of vitamin D deficiency on treatment of osteoporosis is not studied well in detail in Indian population. This is the first Indian study which has carefully analyzed these important associations through a well defined randomized controlled trial in elderly patients with osteoporosis.

**Material and Methods**

This prospective randomized controlled study was carried out at Department of Orthopaedic Surgery, Era’s Lucknow Medical College, Lucknow from January 2016 to June 2017 (18 months) with an aim to find out correlation between osteoporosis severity and vitamin D levels in elderly patients coming with complaints of generalized body pain and to evaluate the effect of vitamin D supplementation in treatment of osteoporosis.

The patients included in the study were (1) diagnosed cases of primary osteoporosis (2) were of age more than 60 years belonging to both the sexes and (3) those patients whose vitamin D levels were less than 20ng/ml. The patients with secondary osteoporosis, with tumors and secondary infection and patients unwilling to follow-up and participate were excluded from the study.

After explaining the details of procedures and obtaining informed consent, the patients were allocated through a computer generated randomization to one of the two groups of 40 members each. Detailed history along with present and past history of fractures was taken and thorough examination was done. Dietary habits, duration of sun exposure and milk intake of the patients were evaluated by dietary recall method.

The investigations performed were routine hemogram, serum blood sugar, liver and renal function tests, serum vitamin D levels and Bone Mineral Density (BMD) evaluation by Dual Eenergy Xray Absorptiometry (DEXA).

BMD evaluation was performed for hip region – including trochanter, femoral neck and intertrochanteric areas and in


The Age of patients ranged from 60 to 78 years. Maximum number of patients were aged 66-70 years (41.3%). Majority of patients were females (n=51; 63.7%). Female to male ratio was 1.75:1. A total of 4 (10%) of Group I and 5 (12.5%) of Group II patients had a history of fractures. All the patients had T-scores below -2.5 with respect to reference values for Asian population. Baselines level of both the groups were outlined. (Table 2 & Graph 1) 

At baseline, mean T-score values were -2.93±0.24 in Group I and -2.89±0.19 in Group II. On evaluating the data statistically, the difference between two groups was not found to be significant (p=0.442). At baseline, mean vitamin D levels were 12.55±2.35 ng/ml and 11.88±2.39 ng/ml respectively in Groups I and II. Though mean levels were higher in Group I as compared to that in Group II yet this difference was not found to be significant (p=0.207).

At baseline, in both the groups, none of the patients had vitamin D levels in normal range. There were 35 (87.5%) patients with insufficiency and 5 (12.5%) patients with deficiency in both the groups. (Table 3 and Graph 2)Statistically, the vitamin D status was perfectly matched between two groups (p=1).

At 3 months, mean T-score values were -2.67±0.39 in Group I and -2.71±0.45 in Group II. On evaluating the data statistically, the difference between two groups was not found to be significant (p=0.650).

At 3 months, mean vitamin D levels were 17.50±5.19 ng/ml and 12.20±2.31 ng/ml respectively in Groups I and II. Thus mean levels were higher in Group I as compared to that in Group II and this difference significant statistically too (p<0.001).

The proportional data was compared using chi-square test whereas mean differences were compared using Student "t"-test. Within group, changes were studied using paired ‘t’-test. The confidence level of the study was kept at 95%, hence a "p" value less than 0.05 was considered significant.

Results

The BMD was graded with respect to the T scores and was used for evaluation of osteoporosis [13]. Patients with T scores less than -1 were normal, patients with T score -1 to -2.5 were labeled as having osteopenia and patients with T score more than -2.5 were categorized as having osteoporosis. The data was analyzed using Statistical Package for Social Sciences version 15.0. The proportional data was compared using chi-square test whereas mean differences were compared using Student "t"-test. Within group, changes were studied using paired ‘t’-test. The confidence level of the study was kept at 95%, hence a "p" value less than 0.05 was considered significant.

Table 1. WHO criteria for clinical diagnosis of osteoporosis

<table>
<thead>
<tr>
<th>BMD T-score</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-score ≥ -1</td>
<td>Normal</td>
</tr>
<tr>
<td>-1 &gt; T-score &gt; -2.5</td>
<td>Osteopenia</td>
</tr>
<tr>
<td>T-score ≤ -2.5</td>
<td>Osteoporosis</td>
</tr>
</tbody>
</table>

Table 2: Comparison of two groups for T-Score and Vitamin D levels at baseline

<table>
<thead>
<tr>
<th>SN</th>
<th>Parameter</th>
<th>Group I (n=40)</th>
<th>Group II (n=40)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T-Score</td>
<td>Mean</td>
<td>SD</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>Vitamin D</td>
<td>Mean</td>
<td>SD</td>
<td>12.55</td>
</tr>
</tbody>
</table>

Table 3: Between Group Comparison of Vitamin D Deficiency status at baseline

<table>
<thead>
<tr>
<th>SN</th>
<th>Status</th>
<th>Group I (n=40)</th>
<th>Group II (n=40)</th>
<th>&quot;t&quot;</th>
<th>&quot;p&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Insufficiency</td>
<td>35</td>
<td>87.5</td>
<td>35</td>
<td>87.5</td>
</tr>
<tr>
<td>3</td>
<td>Deficiency</td>
<td>5</td>
<td>12.5</td>
<td>5</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Table 4: Comparison of two groups for T-Score and Vitamin D levels at 12 months

<table>
<thead>
<tr>
<th>SN</th>
<th>Parameter</th>
<th>Group I (n=40)</th>
<th>Group II (n=40)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T-Score</td>
<td>Mean</td>
<td>SD</td>
<td>0.25</td>
</tr>
<tr>
<td>2</td>
<td>Vitamin D</td>
<td>Mean</td>
<td>SD</td>
<td>37.23</td>
</tr>
</tbody>
</table>

Table 5: Difference in Change of BMD in different contemporary studies in placebo and vitamin D supplemented groups

<table>
<thead>
<tr>
<th>SN</th>
<th>Author (Year)</th>
<th>Method of measurement / Study Period</th>
<th>Change in Case Group</th>
<th>Change in Placebo group</th>
<th>% Difference of change between case and placebo group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dawson-Hughes et al. (1997)</td>
<td>% Change Overall 12 months</td>
<td>18%</td>
<td>14%</td>
<td>22%</td>
</tr>
<tr>
<td>2</td>
<td>Gardner et al. (2001)</td>
<td>% Change in BMD (ng/ml) L2-L4 12 months</td>
<td>2.98%</td>
<td>-0.21%</td>
<td>3.17%</td>
</tr>
<tr>
<td>3</td>
<td>Lanyon et al. (2017)</td>
<td>% Change in BMD 1 year</td>
<td>0.03</td>
<td>0.04</td>
<td>-33.50%</td>
</tr>
<tr>
<td>4</td>
<td>Present study</td>
<td>Change in T-score 12 months</td>
<td>3.18</td>
<td>2.6</td>
<td>30.00%</td>
</tr>
</tbody>
</table>
At 6 months, mean T-score values were $-1.47\pm1.27$ in Group I and $-2.30\pm0.67$ in Group II. On evaluating the data statistically, the difference between two groups was found to be significant ($p<0.001$).

At 6 months, mean vitamin D levels were $26.44\pm7.25\text{ng/ml}$ and $13.58\pm2.26\text{ng/ml}$ respectively in Groups I and II. Thus mean levels were higher in Group I as compared to that in Group II and this difference significant statistically too ($p<0.001$).

At 12 months, mean T-score values were $0.25\pm1.76$ in Group I and $-0.29\pm1.95$ in Group II. On evaluating the data statistically, the difference between two groups was not found to be significant ($p=0.199$).

At 12 months, mean vitamin D levels were $37.23\pm7.61\text{ng/ml}$ and $27.45\pm8.58\text{ng/ml}$ respectively in Groups I and II. Thus mean levels were higher in Group I as compared to that in Group II and this difference was significant ($p<0.001$). (Table 4 & Graph 3)

At 12 months, in Group I, 27 patients (67.5%) had normal BMD, 11 (27.5%) had osteopenia while remaining 2 (5%) had osteoporosis. On the other hand, in Group II, 24 (60%) patients had normal BMD, 2 (5%) had osteopenia and remaining 14 (35%) had osteoporosis. Proportion of those with osteoporosis was higher in Group II as compared to that in Group I, though this difference was not significant statistically ($p<0.001$). (Graph 4)

At 12 months, in Group I, 38 (95%) patients had attained vitamin D status in normal range while remaining 2 (5%) had insufficiency whereas in Group II, 28 (65%) patients had deficiency and remaining 14 (35%) had insufficiency. On comparing the data statistically, the difference was found to be significant ($p<0.001$). (Graph 5)

No adverse effect/complication owing to vitamin D supplementation was noted during the entire course of study.

**Discussion**

Osteoporosis is a common skeletal disorder that is characterized by compromised bone strength predisposing to an increased risk of fracture. Bone strength is reflected by both bone mass and bone quality [1]. After the age of 50 years the prevalence of osteoporosis and incidence of osteoporotic fractures rise substantially with age [14,15]. In view of the increasing life expectancy and increasing focus on the health and well-being of elderly, the focus has shifted to understanding the pathogenesis and management of elderly especially osteoporosis.

Evidence has shown that vitamin D enhances intestinal absorption of calcium and phosphate [14]. Low concentrations of vitamin D are associated with impaired calcium absorption, a negative calcium balance, and a compensatory rise in parathyroid hormone (PTH), which results in excessive bone resorption [14,15]. In large scale epidemiological studies, serum 25(OH)D3 levels have been found to be associated with bone mineral density in both men and women [13]. Evidence has shown that supplementation of vitamin D3 400 IU has a positive impact on total hip BMD [14] as well as overall improvement in musculoskeletal system health [16]. However, clinical evidence regarding usefulness of vitamin D supplementation among elderly is scarce and limited. Hence, the present study was carried out with an aim to assess the vitamin D levels in elderly patients with osteoporosis and to correlate them with severity of osteoporosis and to assess the role of vitamin D supplementation in treatment of osteoporosis in elderly.

Randomized clinical trial is the best design to evaluate the efficacy of an intervention to be measured prospectively. They are considered to be the hallmark of evidence-based medicine [17]. The major advantage of RCTs is the straightforward investigation of cause–effect relationships with minimal bias and confounding factors. In our study, the patients were randomly allocated to one of the two groups, a total of 40 (50%) received vitamin D supplementation along with standard treatment for osteoporosis and comprised the Group I or case group of study while remaining 40 (50%) did not receive any additional treatment along with the standard treatment and comprised the placebo group or Group II of the study. The two groups were matched for age, gender and clinical profile.

Age of patients enrolled in the study ranged from 60 to 78 years. Overall, the mean age of patients was 67.29±3.76 years. Maximum number of cases were aged between 65 and 70 years (41.3%). Compared to present study, Dawson-Hughes et al [18] in their study included elderly above 65 years of age and reported the mean age of their patients above 70 years. In another study, Grados et al [19] reported the mean age of their patients to be 75 years. Mukaiyama et al [20] reported the mean age of their patients as 69.4 years. However, Larsen et al [12] in their study had mean age of patients less than ours (61.1±7.6 years). Generally, age >65 years is considered to be the age at which the decline in dermal capacity to produce vitamin D reaches to its nadir. However, this decline is not simultaneous and happens gradually. In present study, we defined the elderly as 60 years and using a purposive sampling selected only those patients who had vitamin D levels lesser than normal range. Difference in mean age of patients in different series might be reflective of the average life expectancy in different environments. In India, the average life expectancy is relatively lesser, the average age of elderly in present study is slightly lesser.

The present study showed a skewed male-female percentage
with 63.7% of patients being female. The prevalence of osteoporosis is much higher in women as compared to men [3]. In developed countries like US where systematic health records are available the prevalence of osteoporosis is almost four times higher in women as compared to men [4]. In different intervention studies too, the gender ratio has been reported to be skewed with more women as compared to men. Dawson-Hughes et al [18] in their study had a male-female ratio of 0.83. On the other hand, Gardos et al [19] and Mukaiyama et al [20] conducted their study in an exclusive female sample only. However, Larsen et al [12] in their study had higher number of males (M:F 1.62) as compared to females.

In present study, all the cases had T-scores less than -2.5 indicative of osteoporosis. Mean vitamin D levels were 12.55±2.35 ng/ml and 11.88±2.39 ng/ml respectively. Vitamin D levels were in insufficiency and deficiency categories in 87.5% and 12.5% patients in case and control groups, thus showing a perfect matching of two groups.

In present study, in study group mean T-scores showed a change from -2.93±0.24 to 0.25±1.76 (Total change 3.18) whereas in control group the mean T-scores showed a change from -2.89±0.19 to -0.29±1.95 (Total change 2.60). Thus showing that percentage change in T-scores was 30% higher in case group as compared to that in control group. The pattern of change in BMD status in placebo group and case group in different contemporary studies is as follows:

Pattern of change in bone mineral density in different groups has been evaluated using different methods. In present study we studied it in terms of change in T-scores whereas previous studies [12,18,19] have studied it in terms of change in absolute BMD values. In order to make the results of different studies comparable, we converted the change in different studies into proportional changes in BMD or T-scores and studied the % difference of change between placebo and supplemented groups. In different studies the one-year % difference in change of BMD between supplemented and placebo groups show a high variability showing a difference ranging from -33.3% to 22%. There are two studies showing a benefit of addition of vitamin D supplementation [18,19]; these two have shown a % difference of 22% and 3.17% respectively between supplemented and placebo groups respectively. The findings of present study are close to the observations made by Dawson-Hughes et al [18] who showed that at the end of one year the % difference of change between case and placebo group is 22% which is close to 30% difference studied in present study. Interestingly, the study of Larsen et al [12] showed % change in BMD to be -33.3% lesser in supplemented group as compared to placebo group at the end of one year, however, in the second year of intervention they found that compared to placebo group, the percentage change was 800% higher in supplemented group. One must understand that a variation in response to treatment in different studies could probably be owing to difference in profile of patients in different studies. The present study was carried out in a tropical country where natural source of vitamin D is available in plenty whereas most of the previous studies have been carried out in western countries where exposure to sun is relatively lesser. Dietary differences might also contribute for the difference in outcome of study. One of the difficulty in comparing the results of present study with the previous studies was the method of measurement. In present study while focusing more on the qualitative transformation from osteoporosis to osteopenic and normal BMD status we measured the outcomes in terms of T-scores. The reason for taking T-scores instead of direct BMD measurements was the fact that we made a combined assessment for both males and females and taking BMD values as the single measurement might have confounded the relationship as the absolute BMD values for males and females vary, moreover, the normative values are also governed by age, hence taking these values in terms of T-scores provided standardization of results.

As far as extraordinary behavior of treatment response in the study of Larsen et al [12] is concerned, these might be attributable to the fact that their study was carried out in a specific group of pre-diabetic patients, however, the vitamin D supplementation showed a promising response in the second year of intervention, thus indicating that systemic disorders might affect the dynamics of vitamin D supplementation on the attenuation/upgradation of bone mineral density among osteoporosis patients.

The differences in results of different studies must also be considered in view of difference in initial vitamin D levels. In present study, both the groups did not have vitamin D levels in normal range (mean vitamin D levels 12.55±2.35 ng/ml and 11.88±2.39 ng/ml respectively in supplemented and placebo groups respectively). However, Dawson-Hughes et al. [18] in their study reported the initial 1,25-OH Vitamin D levels to be 33.3±13.6 ng/ml and 33.0±16.3 ng/ml respectively in placebo and supplemented group. In another study, Grados et al. [19] included only those cases having vitamin D levels <12 ng/ml. On the other hand, Larsen et al. [12] in their study had vitamin D levels of 58.5±23.0 and 59.0±18.4 nmol respectively (equivalent to 23.4 and 23.6ng/ml respectively) in supplemented and placebo groups respectively. These differences in initial vitamin D levels definitely might have an impact on the outcome.

In present study, in qualitative terms too, we found that vitamin D supplemented group provided a better outcome as
compared to placebo group. At the end of the study, in present study, only 5% patients in supplemented group had BMD in osteoporotic range as compared to 35% patients in placebo group (difference of 30%). These findings in turn substantiate the observations made for the change in T-scores. On reviewing the literature, we did not come across any study evaluating the outcome in qualitative terms. The reason for this could be that other workers mainly attempted on the absolute change in BMD instead of a qualitative change in BMD status. However, other studies had evaluated the qualitative outcome in terms of reduction in non-vertebral fracture incidence over a long term period (upto 3 years) [18]. However, the present study was limited to only one year assessment and hence it was difficult to study the qualitative changes in terms of reduction in fracture incidence. Moreover, the sample size of the study was another issue prohibiting the study of outcome in terms of fracture risk.

There are design related differences in different studies, however, most of the workers agree that addition of vitamin D supplementation helps in restoring the BMD status rapidly. In present study, we also evaluated the impact of addition of vitamin D supplementation on the serum vitamin D levels. Although at the start of treatment, vitamin D levels were in insufficiency and deficiency category in all the patients in both the groups, however, at the end of one-year 95% patients in supplementation group and 65% in placebo group had achieved normal vitamin D levels. Although the change from vitamin D deficiency/insufficiency to normalcy in the supplemented group could be viewed as an effect of vitamin D supplementation, however, the positive change in vitamin D status in placebo group could be attributed to the universal recommendation of adequate sun exposure and intake of diets rich in calcium and vitamin D. This additional intervention might be one of the other reasons for having a better and speedy outcome in both the groups. Lifestyle and dietary factors might play an important role in determining the extent of change in vitamin D status. In their study, The present study did not record any specific adverse effect or complication in either of two groups. In different studies reviewed by us too, no such adverse effect has been reported.

The findings of present study thus show that vitamin D supplementation might be a useful modality to speed up the change in BMD status of elderly undergoing treatment for osteoporosis. Dawson-Hughes et al. [18] showed that in men 25-OH vitamin D3 levels showed an increase of 11.8 ng/ml in case group and -2.68 ng/ml in placebo group respectively whereas in females this change was +16.1 ng/ml in case group and +0.7 ng/ml in placebo group, thus showing that gender differences might affect the direction of change even in placebo group. In present study we had an additional supplementation in terms of diet and sun-exposure.

Two limitations of present study were length of study and sample size, owing to which the long-term impact of vitamin D supplementation in terms of rate of change in BMD could not be studied. Given the variable pace of change in T-scores during different periods of study as observed in present study and as depicted by Larsen et al [12] who observed different patterns of treatment response in placebo and supplemented groups during the first and second year of therapy, it is essential to understand whether the benefit of adding vitamin D supplementation sustains beyond the 12 months period. Similarly, in the absence of long-term follow up and small sample size the present study is not in a position to assess the benefit of adding vitamin D supplementation in terms of fracture risk. Hence, further studies are recommended to be carried out for a longer follow-up duration and in a larger sample size.

**Conclusion**

On the basis of present study, it can be concluded that supplementation of vitamin D helped to speed up the bone mineral density transformation, thus helping in bone formation. This supplementation also helped to improvise the vitamin D status among elderly, however, the usefulness of this supplementation seemed to reach at optimum level at 12 months when mean BMD T-scores did not show a significant difference between two groups. Given the generalized vitamin D deficiency among elderly with osteoporosis, supplementation of vitamin D levels should be recommended owing to its potential in speeding up the treatment process.

**References**


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