



INVESTIGATING THE EFFECTS OF CALCIUM AND CALCIFEROL AUGMENTATION ON OSTEO-MINERAL IMPENETRABILITY DURING EARLY BREASTFEEDING

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Abstract:

Lactation is a physiological process of milk secretion involving many physiological factors that possess strong potential to influence bone mineral density (BMD) which is the best tool to analyze the fracture rate in later life. A randomized control trial was conducted to investigate the effects of calcium and calciferol augmentation on osteo-mineral impenetrability during early breastfeeding. In this study, 60 lactating mothers divided into 2 groups i.e., control and treatment groups, were observed for 8 weeks. Pre-assessment of all the patients was conducted at the start of the trial. The control group received placebo and treatment group received calcium and calciferol supplementation. After an intervention of eight weeks, post assessment of BMD T score, BMD Z score, serum calcium, and serum vitamin D levels was conducted. Statistical analysis revealed that the treatment group had a mean serum calcium level of 10.12 ± 0.429 ($P < 0.001$), serum vitamin D3 level 13.30 ± 2.23 ($P = 0.003$), BMD T score -2.32 ± 0.376 ($P = 0.03$), and Z score -2.55 ± 0.40 ($P = 0.028$). These results showed statistically significant effect of vitamin D and calcium supplementation on serum calcium and 1,25-dihydroxycholecalciferol level which substantially increased the BMD values (T-scores) (Z-scores) for participants in the treatment group. Combined supplementation of calcium and vitamin D improved the BMD during early lactation which can delay osteoporosis and osteopenia.

Key words: Lactation, Breastfeeding, Calcium, Vitamin D3, BMD T and Z scores.

INTRODUCTION

Lactation is the process that provides food to a baby for his physical and mental growth and well-being. This biological process is just like a tradition that is shared by every woman universally and by giving their body's nutrients to their offspring, they might become malnourished. This malnutrition becomes the major cause of bone deterioration (1). Lack of various nutrients leads

toward specific diseases (2). Demand for various nutrients also increases to maintain homeostasis and tissue repair. Supplemental food additives proves to be a best treatment regimen as seen in TB therapy (3). In Pakistan, the prevalence of osteoporosis is 38.5% accompanied by distinctive figures of 38.7%, 8.9%, and 38.4% in the lumbar, hip, and forearm regions respectively (4). The most common change in bones during lactation is the excess removal of minerals from bone (demineralization) which leads to osteopenia and osteoporosis. The mechanism behind this mineral resorption is the excess production of estrogen during gestation, which is the main cause of sustaining bone mineral density.

Breastfeeding exhibits some drastic effects on bone minerals when the mother's diet is poor. So, it should be compulsory to analyze this condition and diagnose it earlier to prevent the complications of pregnancy or lactation-associated osteoporosis (PAO) (5). After pregnancy, level of estrogen drops intensely reducing the mineral content of bones. Breastfeeding is a phenomenon that needs more and more content of different minerals and vitamins. That's why lactating women ensure the maximum intake of vitamins and minerals to avoid any chronic disease crises, specifically intake of vitamin D and calcium during breastfeeding (6). Basically maximum portion of the mother's calcium transfers to the newborn through breastfeeding, this amount is approximately three hundred milligrams of Calcium per day and a dual amount in case of doublet. Result of this, five to ten percent of the mother's bone mineral content is lost during lactation (7).

Studies show that around about 200mg of calcium per day is provided by breastmilk, if no supplementation is administered then this mechanism weakens the maternal bone density. According to America health society Recommended Dietary Allowance of Calcium is 1000-13000 mg per day (8), (9). This must recommendation is due to hormonal dependent supply of calcium which enhances skeletal resorption during breastfeeding. Vitamin D is also essential for maintenance of bone health and its depletion (serum level < 20 ng/mL) and inadequate amount in the body (serum level < 30 ng/mL) is related to bone and muscle health (10). Also, Vitamin D play significant role as immunity booster and it was seen that deficiency of serum vitamin D acts as a major factor in initiating both active and mycobacterium Tuberculosis (11). Various studies proved that supplementation of both calcium and calciferol minimize the bone loss (12). Low mineral content in skeleton is considered to be a major risk factor for both fracture and deterioration of bone during early breastfeeding (13), (14). According to WHO, osteo-mineral impenetrability is the most accurate analysis for the assessment of bone strength and amount of mineral content in skeleton (15).

Young age is the best predicted date of one's bone density and bone strength. If a person has maximum mineral density, then he or she will never prone to osteopenia in later life, totally depend upon the bone strength. As many studies indicated that osteopenia is the hallmark of osteoporosis and this condition is irreversible, researches emphasized on proper intake of essentials minerals and vitamins to ensure good bone density and overall health along with proper physical activity (16).

Osteoporosis is of many types but current study focused on the osteoporosis that is associated with pregnancy and lactation. This condition is too dangerous because in PAO, spontaneous bone fractures occur mostly in spine and pelvic regions. Majority cases noted at the last stages of gestation period and during lactation (16). But this condition is temporary and cured within several months. Major complications that patients had to face are severe pain in lumber region that leads to hardness of bone ultimately due to hormones fluctuations. This condition is still undiagnosed. Mostly these cases are reported in those females who have with their first pregnancy (17). On the other hand, chances of this disease are less in those females who have experienced uncomplicated gestational period in previous life. It should be diagnosed earlier to treat this disease on time (18). Current study attempts to clarify the effect of calcium and vitamin D supplementation on BMD to delay the chances of osteoporosis and osteopenia in early lactating females.

MATERIALS AND METHODS

Study area

This study was performed in Saira Memorial Hospital and Ittefaq Hospital Lahore, from February 2023 to May 2023.

Sample size

The sample size was calculated from the online calculator Raosoft (Raosoft 2020). The study sample size was 60 participants (n=30).

Study groups.

Selected subjects for this study were divided into two groups:

Treatment group

This group received Calcium (1000mg) and Vitamin D (400IU) supplementation.

Control group.

This group received placebo capsules (olive oil)..

Inclusion criteria

- Lactating females
- Mothers having first postpartum period.
- Age must be between 25-35 years.
- Who was willing to be a part of this research.

Exclusion criteria

- Those who were already taking any vitamin D or Calcium supplement were excluded.
- Females with the second or third postpartum period.
- Lactating females with age of more than 35 years
- Having history of any physical injury
- Having history of any psychological disorder
- Having addiction of smoking and alcohol abusing

Data collection procedure

1. Verbal and written consent was obtained from each participant.
2. The laboratory findings of the study participants were communicated with the responsible clinician assigned.
3. The parameters of serum calcium levels were analyzed to determine the concentration of this vital mineral in the bloodstream. Serum Vitamin D3 levels were also assessed to gauge the presence of this crucial nutrient, known for its essential role in bone health and overall well-being. Furthermore, Bone Mineral Density (BMD) tests were included in the assessment.
4. For assessment of Serum Ca and Vit D level, blood was collected with care. Adequate safety precautions were taken to ensure test results would be reliable. Sample contamination and infection from blood-transmissible pathogens was prevented. Protective gloves were worn when collection and handling of blood samples were done. Lancets, needles and syringes were sterilized (19).

Ethical approval

The study was approved by the Research and Ethics Committee of Riphah International University, Lahore. (No. REC/RCR & AHS/22/0807).

STATISTICAL ANALYSIS

The data was analyzed through different statistical tests by using SPSS 26.0. statistical software. A paired t-test will be used to compare the mean of quantitative variables with normal distribution in each group between the beginning and the end of the study. The t-test will be used to compare the mean between the two groups at the beginning and end of the study. A repeated ANOVA test was used for the variables measured two times during the study. Data were presented as mean \pm SD and $p < 0.05$ was considered as level of significance.

RESULTS

The present study compares Serum Calcium level, Vitamin D level and T and Z scores of Bone Mineral Density (BMD) test in pre and post testing subjects of both groups (n= 60) including 30 (50%) participants in the control group and remaining 30 (50%) in the treatment group. Serum samples were collected and BMD scores of 60 subjects that were enrolled in this study after postpartum were calculated. This serum collection was further used to test serum calcium level and vitamin D3 level. Bone Mineral Density test evaluates bone density or thickness by using X- rays, so it measures calcium and minerals in bone. In BMD test, results show two scores, one is T Score and the other is Z score. T-scores compare the bone density of the participant with the bone density of a healthy person, whereas Z-scores use the average bone density of people of the same age, sex, and size as a comparator. Normal T score value is 1SD (+1 and -1), (-1 to -2.5 SD) indicates low bone mass and shows osteopenia, a T score of -2.5 or lower than this indicates the presence of osteoporosis. Normal Z scores are -2.5 to 2.5. The standard deviation of T and Z scores related with mean are recorded.

Baseline values of selected subjects

Age distribution shows that all participants of control group and 80% of participants in treatment group were of age in between 25-30 years while 20% individuals of treatment group were in age group between 30-35 years. In control group, 43.3% participants were osteoporotic and 56.7% were osteopenic. In treatment group 50% participants were osteoporotic and 50% were osteopenic. Average calcium levels in participants were (8.1-10.4 mg/dl), calciferol levels were (7.5 to 15 IU), BMD T score(1.5-2.8g/cm²) and BMD Z score was (1.7-2.9g/cm²).

Table 1: Therapeutic effect of Calcium and Vitamin D on serum Calcium, vitamin D3, BMD T and Z Scores.

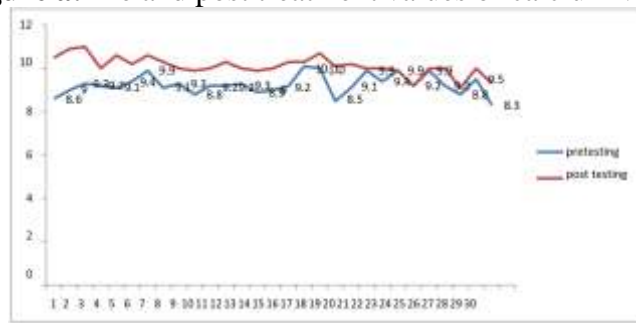
Biochemical parameter	Groups	Before treatment	After treatment
		Mean \pm SD	Mean \pm SD
Serum Calcium Level (mg/dl)	Control	9.29 \pm 0.52	9.25 \pm 0.55
	Treatment	9.26 \pm 0.45	10.12 \pm 0.42
Vitamin D3 (IU)	Control	11.56 \pm 2.31	11.45 \pm 2.23
	Treatment	10.71 \pm 1.86	13.30 \pm 2.35
BMD T score (g/cm ²)	Control	-2.26 \pm 0.40	-2.55 \pm 0.40
	Treatment	-2.38 \pm 0.30	-2.30 \pm 0.46
BMD Z score (g/cm ²)	Control	-2.47 \pm 0.40	-2.32 \pm 0.37
	Treatment	-2.58 \pm 0.34	-2.09 \pm 0.45

* post Serum Ca $p = 0.000 < 0.05$, post Vit D $p = 0.00 < 0.05$, post BMD T- score $p = 0.02 < 0.05$, post BMD Z- score $p = 0.03 < 0.05$

Effect of Calcium & Vit D on Serum Calcium

After eight weeks of intervention, post testing of both treatment and control group shows: the calcium serum level of control group is 9.25 \pm 0.55 and for treatment group serum calcium level is 10.12 \pm 0.429 ($P < 0.001$). This effect is statistically significant.

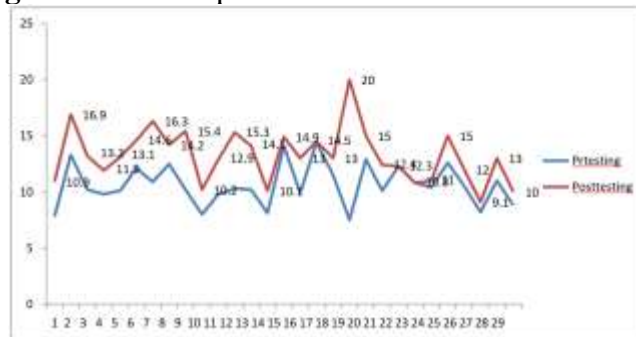
Figure a: Pre and post treatment values of calcium values



Effect of Calcium & Vit D on Serum Vit D

The vitamin D3 level in the control group is 11.45 ± 2.237 and that of treatment group is 13.30 ± 2.23 ($P=0.003$). This shows significant impact on BMD values.

Figure b: Pre and post treatment values of Vitamin D3



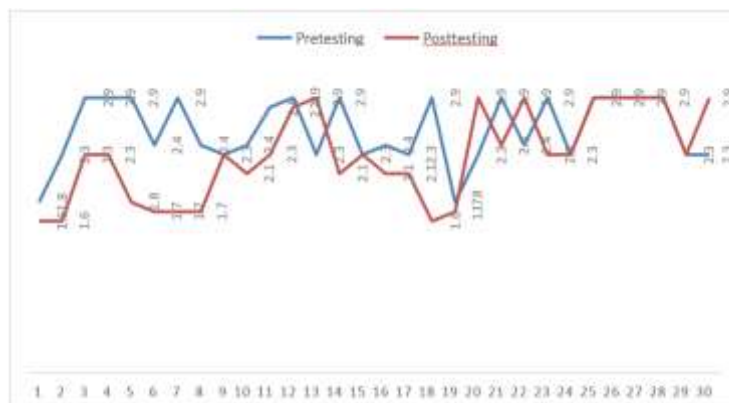
Effect of Calcium & Vit D on BMD T & Z Scores

The BMD T score is -2.32 ± 0.376 ($P=0.03$) in control group and in treatment group, BMD T score -2.09 ± 0.450 indicates improvement. BMD Z score is in control group -2.55 ± 0.40 and in treatment group, Z score -2.30 ± 0.460 ($P=0.028$) also indicates positive effect.

Figure c: BMD pre and post T score levels



Figure d: BMD pre and post Z score levels



This shows that after the intervention of Calcium (1000mg) and Vitamin D3 (400IU) supplementation in the treatment group, serum values of calcium and Vitamin D3 were improved which have positive impact on BMD T and Z scores because body needs calcium along with Vitamin D for dense bones. Because without Vitamin D, the bones cannot absorb calcium so, to increase intestinal calcium absorption, Vitamin D is necessary for body. Figure c & d demonstrates T and Z score enhancement in BMD which demonstrates that bones are becoming dense by absorption of Calcium and Vitamin D supplements in bones after intervention which can be seen clearly in (figure a) and (figure b) that there is significant improvement in calcium and vitamin D level in pre and post testing of treatment group. The BMD T and Z scores are also improved after intervention in post testing of treatment group. Increase in BMD indicates that there will be lower or delayed chances of osteoporosis and osteopenia as compared to pretesting of treatment group because of Calcium and Vitamin D supplements as they promote bone mineral density and could help prevent in delaying osteoporosis fractures.

DISCUSSION

In the present study, combined effect of calcium and vitamin D on serum Calcium, vitamin D3, BMD T and Z Scores were analyzed for forty-five days. This study concluded that Calcium(1000mg) and Vitamin D(400IU) supplementation significantly improves the values for serum Calcium, vitamin D3, BMD T and Z Scores in treatment group as compared to control. International researches concluded that diet can change the risk factors of osteoporosis such as low level BMD T and Z Scores.

Our results showed that there is improved BMD by the administration of Calcium and Vitamin D during lactation which are also supported by the findings of Lampropoulou-A.K, et al. who reported that in patients with calcium and vitamin D supplementation, there are significant increases in LS BMD at 12 and 24 months (20). Similarly, our results are in line with Cerit ET, et al. and Jadhav A, et al who reported that females during pregnancy and lactation are at risk of developing osteoporosis (PLO) and we need to administer appropriate doses of calcium supplements during that period (21) (22).

Many studies showed that low calcium and vitamin D is responsible for low Z and T score in BMD test. Our study is parallel with work which also described the same situation that low levels of serum calcium and vitamin D is associated with low Z and T scores (23). Our results showed that osteoporotic fractures were likely to be more common in patients with low BMD and are in line with the work of Berry et al., 2019 (24). Our findings suggest that low calcium and vitamin D levels are associated with fractures and it shows similar results to the work by Jadhav A, et al who described that bone fractures are due to lack of calcium (20).

Results of the current study also exhibit that higher BMD values in PLO is associated with delaying the chances of osteopenia and osteoporosis along with fragility of bones especially in the hip and lumbar spine (25). This concluded that an increase in lumbar spine mineral density delays the chances of osteoporosis and osteopenia in early lactating females.

CONCLUSION

Considering the above findings, it can be concluded that Calcium and Vitamin D supplementation should be recommended during early lactation for better improvement of bone mineral density (BMD) which may delay the chances of osteopenia and osteoporosis in early lactating females and later on. Limitations of the current study are a short time period to conduct this research and the least sample numbers to remove the error of research.

CONFLICT OF INTEREST:

There is no conflict of interest.

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