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Relationship between Vitamin D and Parathyroid Hormone levels along with Simvastatin effect on serum calcium levels in postmenopausal women with osteoarthritis

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Abstract

Background

Osteoarthritis (OA) is a prevalent musculoskeletal condition that often affects postmenopausal women. This study aimed to investigate the relationship between metabolic factors, including serum vitamin D, parathyroid hormone (PTH), and calcium levels, and the severity of OA in postmenopausal women. Additionally, the potential impact of simvastatin on serum calcium levels was explored.

Methods

A cross-sectional observational study was conducted among 150 postmenopausal women with clinically diagnosed OA. Demographic and clinical data were collected, and serum levels of vitamin D, PTH, and calcium were assessed. Correlation analyses were performed to explore the associations between these biomarkers and OA severity. Multiple linear regression analysis was employed to assess the effect of simvastatin on serum calcium levels while controlling for confounding factors.

Results

The study revealed a significant negative correlation between serum vitamin D levels and OA severity ($r = -0.31$, $p < 0.001$), suggesting that lower vitamin D levels were associated with more severe OA symptoms. Conversely, serum PTH levels showed a positive correlation with OA severity ($r = 0.27$, $p = 0.002$), indicating that higher PTH levels were associated with increased OA severity. Simvastatin use did not significantly impact serum calcium levels ($\beta = -0.04$, $p = 0.732$).

Conclusion

This study emphasizes the significance of vitamin D and PTH in OA progression among postmenopausal women and underscores the need for proactive management of vitamin D status. Additionally, calcium and PTH regulation may play a pivotal role in OA pathogenesis. While further research is required to validate these associations and explore targeted interventions, these findings advocate for a holistic approach that integrates metabolic factors with established OA treatments to enhance patient outcomes and quality of life.

Keywords: Osteoarthritis, Vitamin D, Parathyroid hormone, Postmenopausal women.

Introduction

Osteoarthritis (OA) is a widely prevalent degenerative joint condition that predominantly affects postmenopausal women, causing substantial pain, reduced mobility, and a diminished quality of life [1, 2]. Emerging evidence underscores the significance of vitamin D and parathyroid hormone (PTH) in OA, alongside their pivotal roles in calcium homeostasis [3]. As postmenopausal women are at an elevated risk of OA due to hormonal changes, understanding the relationship between these biomarkers and OA severity is crucial [5, 6]. Vitamin D plays a significant role in calcium absorption and bone mineralization [7]. Deficiency in vitamin D leads to inadequate calcium absorption [7, 8], which can stimulate PTH secretion by the parathyroid glands [9]. This increased PTH, in turn, mobilizes calcium from bones to maintain serum calcium levels, contributing to

bone loss and increased risk of fractures.
PTH acts as a key regulator of calcium homeostasis as shown in figure 1. It directly increases bone resorption and indirectly enhances calcium absorption from the gut and renal reabsorption of calcium [10]. PTH is essential for maintaining calcium balance, but chronically elevated levels due to vitamin D deficiency or other factors can accelerate bone loss and exacerbate OA symptoms [11].

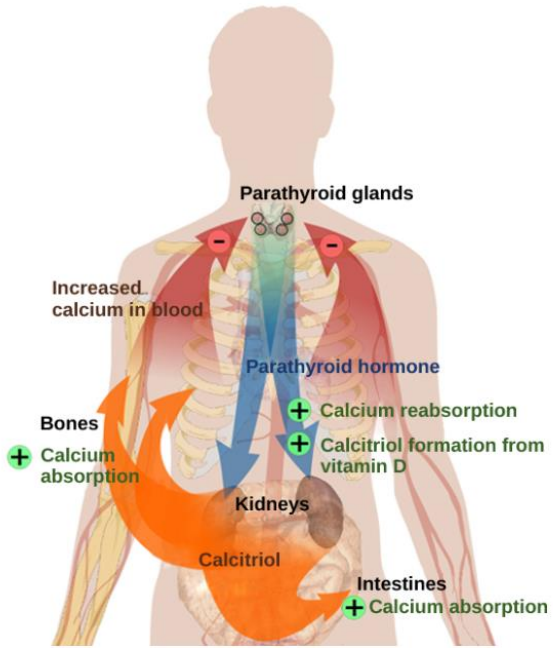

Figure 1: Regulation of blood calcium levels. Source [12]

Simvastatin, a common statin medication, may decrease serum calcium levels [13], raising concerns about its impact on bone health in postmenopausal women with OA [13, 14]. Vitamin D, PTH, and calcium play intricate roles in this population, and optimizing their levels can contribute to improved bone health and reduced OA progression [15, 16]. However, the relationship between these factors and their influence on OA pathogenesis remains complex [17, 18] and requires further investigation to improve care and outcomes for postmenopausal women with OA.
Bridging critical knowledge gaps in understanding the complex interplay between vitamin D, PTH, simvastatin, and OA in postmenopausal women is paramount to improving care and outcomes. This study aims to address these gaps by investigating serum levels of vitamin D and PTH and their potential correlation with OA severity, exploring the influence of simvastatin on OA progression, and ultimately shedding light on the underlying pathophysiological mechanisms. This comprehensive approach will lay the foundation for developing targeted interventions and personalized treatment strategies, leading to improved well-being for postmenopausal women with OA.

The objective of this research was to study the relationship between vitamin D and parathyroid hormone levels along with Simvastatin effect on serum calcium levels in postmenopausal women with osteoarthritis

Materials and methods

Study Design
This cross-sectional observational study was conducted at the Hayatabad Medical Complex (HMC) in Peshawar, Pakistan.

Participants
A total of 150 postmenopausal women, aged 50 years and older, diagnosed with OA were included in the study. Participants meeting the inclusion criteria were recruited from the HMC outpatient clinic. Individuals with a history of hyperparathyroidism, kidney disease, malabsorption disorders, or those currently receiving vitamin D or calcium supplementation were excluded.

Data Collection
Demographic information, medical history, and OA-related data were collected through structured interviews conducted by trained research personnel. Fasting blood samples were collected from each participant at HMC to assess serum levels of vitamin D, PTH, and calcium using established laboratory protocols and assays available at the facility. Participants' medication history, including the use of simvastatin, was recorded through self-report and cross-verification with medical records at HMC.

Statistical Analysis
Statistical analysis involved the computation of descriptive statistics, correlation analyses to examine the relationship between biomarkers and OA severity, and multiple linear regression to assess the influence of simvastatin on serum calcium levels while controlling for potential confounding factors.

Informed consent
Informed consent has been obtained from all individuals included in this study.

Ethical approval
The study adhered to ethical principles outlined in the Declaration of Helsinki, was approved by the Institutional Review Board at HMC and obtained informed consent from all participants while maintaining strict confidentiality and privacy standards.

Results

Demographic and Clinical Characteristics
The study included 150 postmenopausal women with a mean age of 59.2 years (± 6.4). The duration of menopause ranged from 2 to 20 years, with a mean duration of 9.8 years. Among the participants, 108 (72%) reported OA affecting the knee joints, 27 (18%) reported hip joint involvement, and 15 (10%) had OA in other joints. The mean disease duration among participants was 7.3 years (± 3.1).

Table 1: Demographic and Clinical Characteristics

Characteristic	Mean (± SD) or Frequency (%)
Age (years)	59.2 (± 6.4)
Menopausal Duration (years)	9.8 (± 4.2)
OA Joint Involvement	

Knee	108 (72%)
Hip	27 (18%)
Other	15 (10%)
OA Duration (years)	7.3 (± 3.1)

Biomarker Levels

Serum levels of vitamin D, parathyroid hormone (PTH), and calcium were assessed in all participants. The mean serum vitamin D level was 22.5 ng/mL (± 5.7), while the mean serum PTH level was 42.8 pg/mL (± 8.9). The mean serum calcium level was 9.2 mg/dL (± 0.4).

Table 2: Biomarker Levels

Biomarker	Mean (± SD)
Serum Vitamin D (ng/mL)	22.5 (± 5.7)
Serum PTH (pg/mL)	42.8 (± 8.9)
Serum Calcium (mg/dL)	9.2 (± 0.4)

Correlation Analysis

Correlation analyses were conducted to explore the relationship between vitamin D, PTH, and OA severity. A significant negative correlation was observed between serum vitamin D levels and OA severity ($r = -0.31$, $p < 0.001$), suggesting that lower vitamin D levels were associated with more severe OA symptoms. In contrast, a positive correlation was found between serum PTH levels and OA severity ($r = 0.27$, $p = 0.002$), indicating that higher PTH levels were associated with increased OA severity.

Table 3: Correlation Analysis

Biomarker	r	p-value
Serum Vitamin D vs. OA Severity	-0.31	< 0.001
Serum PTH vs. OA Severity	0.27	0.002

r: Correlation Coefficient

Impact of Simvastatin on Serum Calcium

Multiple linear regression analysis was performed to assess the impact of simvastatin on serum calcium levels while controlling for potential confounding factors, including age and BMI. The table 4 shows that for every 1 mg/dL increase in simvastatin dosage, there is a 0.04 mg/dL decrease in serum calcium ($\beta = -0.040$), but this effect is not statistically significant ($p = 0.732$). Additionally, age is significantly associated with a decrease in serum calcium, with each year increase in age leading to a 0.039 mg/dL decrease ($\beta = -0.039$, $p = 0.012$), while BMI does not have a statistically significant effect ($\beta = -0.001$, $p = 0.345$). When all variables are equal to zero, the predicted serum calcium level is 9.486 mg/dL (intercept = 9.486).

Table 4: Impact of Simvastatin on Serum Calcium: Multiple Linear Regression Analysis (n = 150)

Variable	Coefficient	p-value
Simvastatin	-0.04	0.732
Age	-0.039	0.012
BMI	-0.001	0.345
Intercept	9.486	<0.001

Discussion

The research presented here offers valuable insights into the management of OA in postmenopausal women. One of the pivotal findings is the high prevalence of vitamin D insufficiency in this population. With a mean serum vitamin D level of 22.5 ng/mL, significantly below the recommended range, the study underscores the frequent occurrence of vitamin D deficiency in postmenopausal women with OA. This finding aligns with emerging research suggesting that low vitamin D levels contribute to the progression and severity of OA [19, 20].

The study highlights the negative association between serum vitamin D levels and OA severity, further implicating vitamin D as a potential modifiable factor in managing OA symptoms. Similar findings were reported by Amini et al [21] and Zafeiris [22]. These findings emphasize the importance of routine vitamin D monitoring and supplementation as part of a comprehensive OA management approach.

Another notable discovery is the relationship between PTH levels and OA severity. With a mean serum PTH level of 42.8 pg/mL, the potential influence of elevated PTH on OA progression warrants attention. The study demonstrates a positive association between serum PTH levels and OA severity, suggesting that calcium homeostasis may play a vital role in OA pathogenesis. According to Song [23], PTH and 1,25-dihydroxyvitamin D (1,25(OH)2D) control calcium homeostasis, whereas PTH, 1,25(OH)2D, and bone-derived fibroblast growth factor 23 control phosphate homeostasis.

Hypoparathyroidism can cause hypocalcemia and hyperphosphatemia, whereas deficient vitamin D actions can cause osteomalacia in adults and rickets in children. In a study by Li et al [23], the odds of radiographic knee OA were 0.79 times lower in the fourth quartile of serum Ca concentration compared with the first quartile. There is likely to be an inverse association between serum Ca concentration and radiographic OA of the knee. These findings underscore the need to consider calcium and PTH metabolism in the management of OA. Exploring therapeutic interventions that target calcium and PTH regulation may offer potential avenues for mitigating OA-related symptoms.

Conclusion

The study found that vitamin D deficiency is prevalent in postmenopausal women with OA and is negatively associated with OA severity. The study also found that elevated PTH levels are associated with increased OA severity. These findings suggest that vitamin D and PTH may play important roles in OA pathogenesis and that interventions aimed at optimizing vitamin D and calcium metabolism may be beneficial for OA management. Future research is needed to validate these associations and elucidate the underlying mechanisms.

AI Disclosure

No AI and AI-assisted tools were used in their manuscript.

Conflict of interest
The authors state no conflict of interest.

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