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Research article

A correlative study of alkaline phosphatase and calcium in osteoarthritis patients

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Abstract: Osteoarthritis is a degenerative joint disorder characterized by progressive cartilage breakdown and altered bone metabolism. This study aimed to evaluate the correlation between serum alkaline phosphatase (ALP) activity and serum calcium levels in patients with osteoarthritis and to compare these parameters with those of healthy controls to identify deviations from normal biochemical values. A total of 100 osteoarthritis patients (61% male and 39% female), aged 45 years and above, attending the outpatient department of Teaching Hospital Shahdara were included in the study. Serum samples were analyzed for ALP activity and calcium concentration using standard biochemical methods. The results demonstrated significantly elevated serum ALP activity in osteoarthritis patients, while serum calcium levels were comparatively reduced. An inverse correlation was observed between serum ALP activity and serum calcium levels. These findings suggest that alterations in ALP and calcium metabolism are associated with osteoarthritis progression. Measurement of serum ALP and calcium may serve as simple, cost-effective biochemical biomarkers for assessing disease severity in patients with osteoarthritis.

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Introduction

Osteoarthritis is a persistent, reformist sickness that specially influences weight bearing joints that include hips and knees. In osteoarthritis patient expanded bone turnover, diminished bone mineral substance, firmness, and diminished trabecular have been seen. It also causes subchondral bone construction [1]. Osteoarthritis is a typical disease in which changes occur in bone and in synovial joint. It usually happens along with destruction of Bone [2]. The recent experimental research shows that bone mineral density has inverse relationship with osteoarthritis [3]. The centers for disease control and prevention include 240 million individuals worldwide have osteoarthritis, incorporating >30 million individuals in the United States, an expansion from 21 million out of 1990 to 27 million out of 2005 [4].

In a maturing population in 2021, osteoarthritis is set to turn into the fourth driving season for handicap so with the current absence of essential medicine there is an earnest requirement for safeguard measure [5]. Serum alkaline phosphatase, a notable marker of bone disorder, has also been found to be a biochemical marker of different diseases [4]. Studies have shown that alkaline phosphatase can be viewed as a marker of bone development in vitro and in vivo. Serum alkaline phosphatase level increases in case of bone diseases which makes it a marker for osteoarthritis [6]. In examinations, our insightful gathering found that serum magnesium might have a reverse relationship with osteoarthritis. Calcium which has a same place as magnesium in the periodic table share the same controlling framework [7].

The subchondral bone environment in the beginning stages of osteoarthritis have a high concentration of

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calcium because of reabsorption of the bone lattice of osteoclasts. Most of the studies shows that in osteoarthritis calcium level decreases in the late phases of osteoarthritis [8].

Alkaline phosphatase is related with vascular classification while bone alkaline phosphatase (BALP) is a marker of bone development and bone turnover and is utilized in the assessment of skeletal status. In an investigation of patient kang et al tracked down that raised serum alkaline phosphatase connected with low Bone molecular density and more prominent primary harm [9]. After reading these article findings we aimed to find out the relationship between alkaline phosphatase and calcium in osteoarthritis in Pakistani population aged less than or greater than 45 years.

Material and methods

This correlative cross-sectional study was conducted at the Government Teaching Hospital Shahdara (GTHS). A total of 100 patients clinically diagnosed with osteoarthritis were recruited from the outpatient department after obtaining written informed consent. Patients aged 45 years and above of both sexes were included in the study. Individuals with known metabolic bone disorders, chronic kidney disease, liver disease, or those receiving medications known to affect calcium or alkaline phosphatase levels were excluded to minimize confounding effects.

Venous blood samples were collected under aseptic conditions using disposable sterile syringes. Approximately 3–5 mL of blood was transferred into chemistry vials containing heparin as an anticoagulant. The samples were centrifuged at 3000 revolutions per minute (rpm) for 5 minutes to separate the serum. The separated serum was then subjected to biochemical analysis using an automated chemistry analyzer (Selectra Pro M).

Serum alkaline phosphatase (ALP) activity and serum calcium levels were measured using standard enzymatic and colorimetric methods, respectively, as per the manufacturer's instructions. The reference range for serum alkaline phosphatase was considered to be 45–180 IU/L, while the normal reference range for serum calcium was 8.5–10.5 mg/dL.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software, version 20. Quantitative variables, including age, serum ALP, and serum calcium levels, were expressed as mean ± standard deviation (SD). The relationship between serum alkaline phosphatase activity and serum calcium levels was assessed using correlation coefficient analysis. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 100 patients diagnosed with osteoarthritis were included in the study. The age distribution of the study population is summarized in **Table 1**.

Table 1. Descriptive Statistics of age distribution.

Age Distribution				
N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
100	42.00	98.00	61.3400	10.99515

Gender distribution analysis revealed that 61% of the participants were female and 39% were male, indicating a higher prevalence of osteoarthritis among females in the studied population **(Figure 1)**.

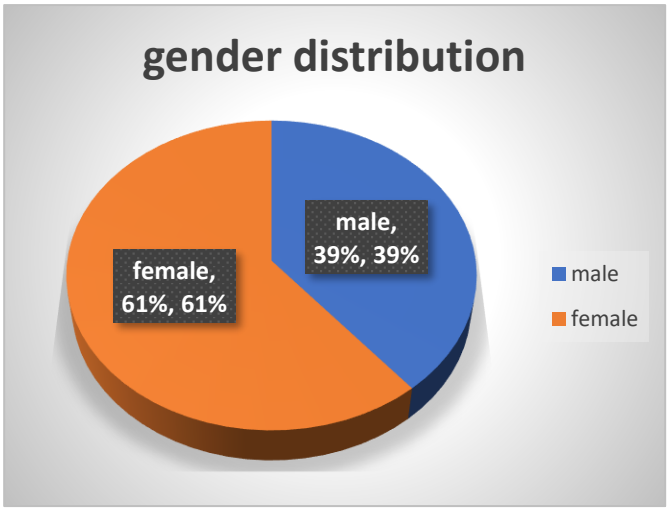

Figure 1. Descriptive statistics of gender.

The minimum age recorded was 42 years, while the maximum age was 98 years, with a mean age of 61.34 ± 10.99 years. This indicates that osteoarthritis predominantly affected older individuals, with the majority of patients falling within the elderly age group **(Figure 2)**.

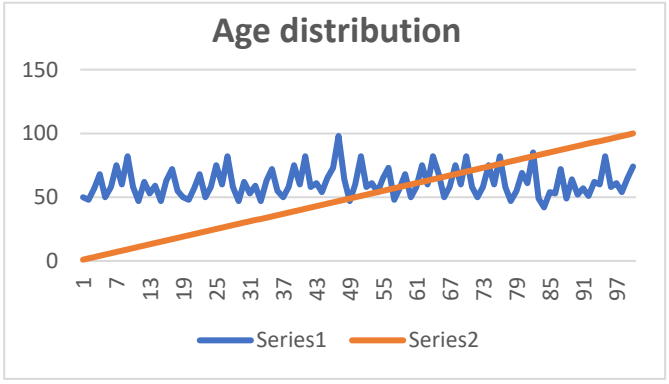

Figure 2. Age distribution.

Biochemical analysis of serum calcium and alkaline phosphatase (ALP) levels is presented in **Table 2**. Serum calcium levels ranged from a minimum of 4.8 mg/dL to a maximum of 10.2 mg/dL, with a mean value of 7.71 ± 1.43 mg/dL, which is below the normal reference range, indicating hypocalcemia in a substantial proportion of patients. In contrast, serum ALP levels showed markedly elevated values, ranging from 186 U/L to 1100 U/L, with a mean level of 340.04 ± 193.13 U/L, exceeding the normal reference range and suggesting increased bone turnover in osteoarthritis patients.

Table 2. Mean value of calcium and alkaline phosphatase.

	N	Minimum	Maximum	Mean	Std. Deviation
Calcium	100	4.80	10.20	7.7090	1.43084
Alp	100	186.00	1100.00	340.0400	193.12988

The Pearson correlation coefficient was found to be 0.12, indicating a weak inverse association between the two biochemical parameters. Despite the weak correlation, the results demonstrate that elevated ALP levels were generally accompanied by reduced serum calcium levels in osteoarthritis patients.

Socioeconomic status analysis **(Figure 3)** showed that the majority of patients (65%) belonged to the lower socioeconomic class, followed by 20% from the middle class and 15% from the upper class, suggesting a higher burden of osteoarthritis among individuals from lower socioeconomic backgrounds.

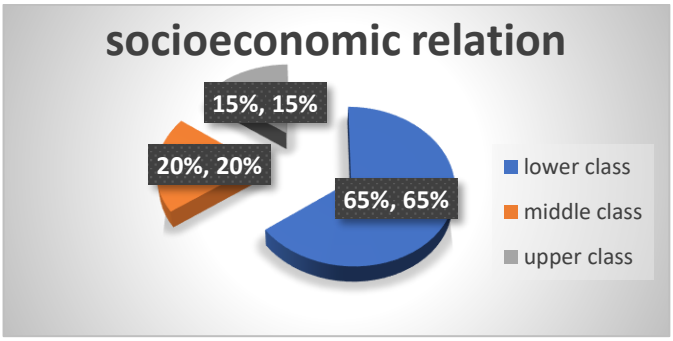

Figure 3. Socioeconomic status.

The distribution of osteoarthritis involvement across different joints is illustrated in **Figure 4**. Knee osteoarthritis was the most prevalent, affecting 48% of patients, followed by spinal involvement in 22%, hand osteoarthritis in 19%, and hip osteoarthritis in 11% of cases, highlighting the knee joint as the most commonly affected site. Further analysis of calcium variation revealed that 72% of osteoarthritis patients exhibited reduced serum calcium levels **(Figure 5)**, supporting the biochemical findings of hypocalcemia in this population.

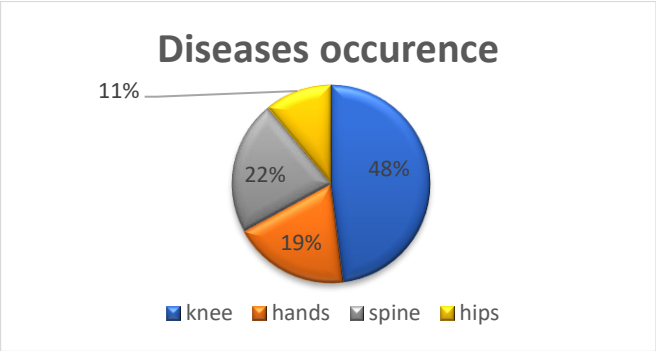

Figure 4. Diseases occurrence in different joints.

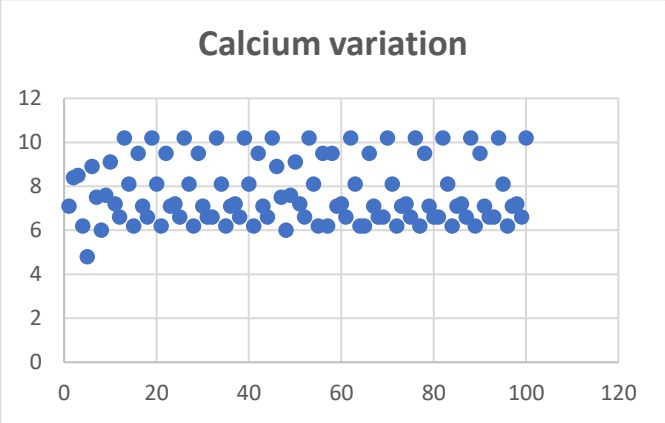

Figure 5. Calcium variation in osteoarthritis patients.

Similarly, analysis of alkaline phosphatase variation **(Figure 6)** demonstrated increased ALP levels in the majority of patients, reinforcing its potential role as a biochemical marker of osteoarthritic changes.

Discussion

In this study we found out that serum alkaline phosphatase is positively associated with osteoarthritis. We observed that higher amount of alkaline phosphatase level in blood serum indicate higher prevalence of osteoarthritis (ankle, knee, spine) [4]. The correlation of alkaline phosphatase with osteoarthritis is not fully understood yet but there are many processes which we need to reconsider. It is possible that serum alkaline phosphatase has a link with low grade inflammation which stimulate inflammatory responses in chondrocytes. Studies shows that serum alkaline phosphatase level has a positive association with CRP and leukocyte counts (inflammatory markers) [10, 11]. In the past serum alkaline phosphatase had consider a marker of aging and burden on joints. Now it is considered a major biochemical marker of joints degeneration [12]. The alkaline phosphatase level elevates in order to maintain the bone regeneration process. This process cause regeneration of eroded bones at the joint ends. Several hormones and pro inflammatory molecules involve in alteration of calcium metabolism. These molecules and hormones causes

reduction of calcium level in blood [13]. The degeneration of cartilage affects the bone and the cytokines present in blood causes bone synthesis which ultimately increased alkaline phosphatase level in osteoarthritis patient serum [14].

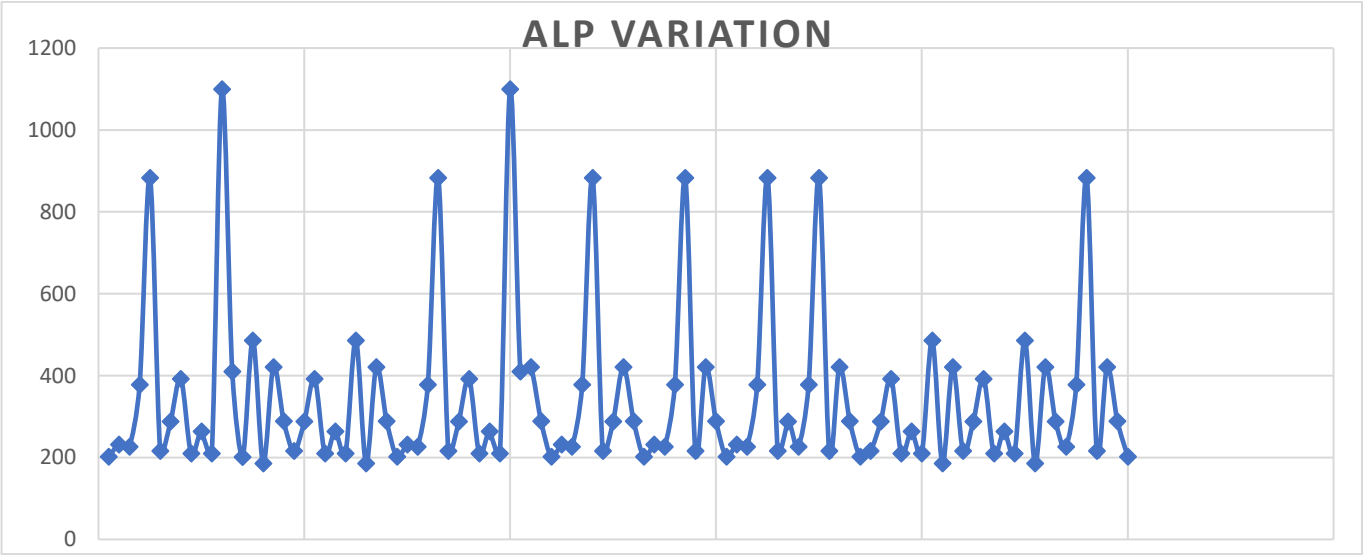

Figure 6. Alkaline phosphatase variations in osteoarthritis patients.

There were many studies on relation of osteoarthritis with calcium but there were no relation found with them [15]. But these studies were on western people who have different life style as compared to Asian people. People of different regions have distinct characteristics among them [16]. Research experiment shows that calcium is involved in the transportation of secretory protein outside the cell [17, 18]. Another study shows that calcium present in blood maybe involve in calcium homeostasis [19]. Above studies tell us that calcium participates in chondrocyte pathological and physiological processes. So, deficiency of calcium can restrict chondrocytes normal functional activity. Although major difference was observed of serum calcium level in alcoholic females and who did not drink alcohol [20, 21]. Our study shows a negative correlation between serum calcium and serum alkaline phosphatase in osteoarthritis patients.

Conclusion

The findings of the present study demonstrate that patients with osteoarthritis exhibit significantly elevated serum alkaline phosphatase levels alongside reduced serum calcium concentrations, reflecting alterations in bone and mineral metabolism associated with disease progression. The observed inverse relationship between serum alkaline phosphatase and serum calcium levels indicates increased bone turnover and possible imbalance between bone formation and resorption in osteoarthritis. These biochemical changes suggest that serum alkaline phosphatase and calcium levels may serve as simple, cost-effective indicators for evaluating disease severity and metabolic involvement in osteoarthritis. Incorporation of these parameters into routine clinical assessment may aid in early detection, monitoring of disease progression, and optimization of therapeutic strategies. Further large-scale and longitudinal studies are recommended to validate these findings and to establish their prognostic significance in osteoarthritis management.

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