Research article

Inverse Relationship Between Serum Alkaline Phosphatase and Calcium in Osteoarthritis Patients

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Abstract: Osteoarthritis (OA) is a progressive degenerative joint disorder characterized by biochemical and structural alterations in cartilage and surrounding tissues. This study aimed to evaluate the correlation between serum alkaline phosphatase (ALP) activity and serum calcium levels in osteoarthritis patients compared with healthy controls to identify deviations from normal physiological ranges. A total of 100 clinically diagnosed OA patients (61% male, 39% female), aged 45 years and above, were recruited from the outpatient department of Teaching Hospital Shahdara, and their serum samples were analyzed for ALP and calcium concentrations. Findings revealed elevated serum ALP levels and comparatively lower serum calcium levels in OA patients. An inverse relationship was observed between these two biochemical parameters, suggesting their potential utility as inexpensive and accessible biomarkers for assessing osteoarthritis severity.

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 (Spector et al., 2005). Osteoarthritis is a typical disease in which changes occur in bone and in synovial joint. It usually happens along with destruction of Bone (DEMİRCİOĞLU et al., 2011). The recent experimental research shows that bone mineral density has inverse relationship with osteoarthritis (Bellido et al., 2011). 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 (Park et al., 2020).

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 (Knott et al., 2011). Serum alkaline phosphatase, a notable marker of bone disorder, has also been found to be a biochemical marker of different diseases (Park et al., 2020). 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. 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 (Li et al., 2016).

The subchondral bone environment in the beginning stages of osteoarthritis have a high concentration of 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 (Jung et al., 2018). 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 (Chen et al., 2018). 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.

Materials and Methods

A total of 100 blood samples were collected from osteoarthritis patients attending the outpatient department of the Government Teaching Hospital Shahdara (GTHS). All participants were aged 45 years or older and provided written informed consent prior to sample collection. Venous blood was drawn using sterile disposable syringes under aseptic conditions to ensure sample integrity. Each blood sample was immediately transferred into heparinized chemistry vials to prevent coagulation and maintain the stability of serum analytes.

The collected samples were transported to the laboratory and centrifuged at 3000 rpm for 5 minutes to obtain clear serum. Following separation, the serum was carefully pipetted and subjected to biochemical analysis using a fully automated chemistry analyzer (Selectra Pro M). Serum alkaline phosphatase (ALP) and serum calcium levels were measured according to manufacturer protocols. The reference range for ALP was considered to be 45-180 IU/L, while the normal range for serum calcium was 8.5-10.5 mg/dL. These values provided a baseline for comparison with the patient cohort and for identifying deviations associated with osteoarthritis.

All collected data were recorded and statistically analyzed using SPSS software (version 20). Descriptive statistics, including mean and standard deviation (Mean ± SD), were calculated for quantitative variables such as patient age. Pearson's correlation coefficient was applied to evaluate the relationship between serum ALP and serum calcium levels, enabling determination of both the strength and direction of association between these biomarkers in osteoarthritis patients. This analytical approach provided a quantitative basis for assessing the potential of ALP and calcium as cost-effective indicators of disease severity.

Results

The demographic characteristics of the study population shows that the age of osteoarthritis patients ranged from 42 to 98 years, with a mean age of 61.34 ± 10.99 years. This distribution reflects the known trend that osteoarthritis predominantly affects older adults. The gender distribution indicates that 61% of the patients were female, while 39% were male, supporting existing epidemiological evidence that osteoarthritis is more prevalent among women. Analysis of socioeconomic status, shown in **Figure 1**, reveals that 65% of the patients belonged to the lower socioeconomic class, followed by 20% in the middle class and 15% in the upper class. This distribution suggests that limited access to healthcare and nutritional deficiencies may contribute to osteoarthritis progression in lower-income groups.
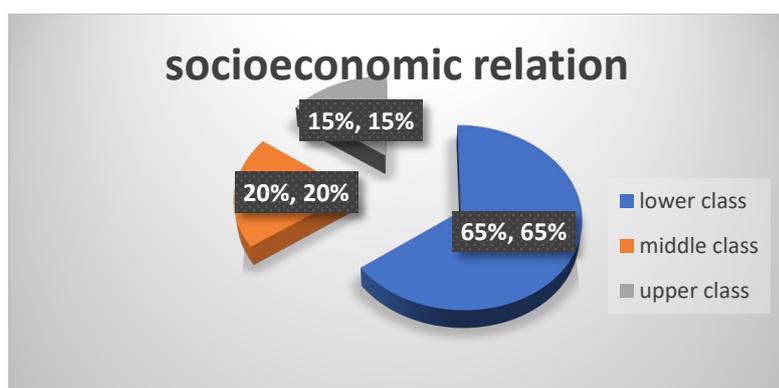

Figure 1. Socioeconomic status.

The pattern of joint involvement is illustrated in **Figure 2**, where knee osteoarthritis was the most common type (48%), followed by involvement of the spine (22%), hands (19%), and hips (11%). These findings align with the typical weight-bearing stress distribution and functional load experienced by these joints, contributing to their susceptibility to osteoarthritic changes.
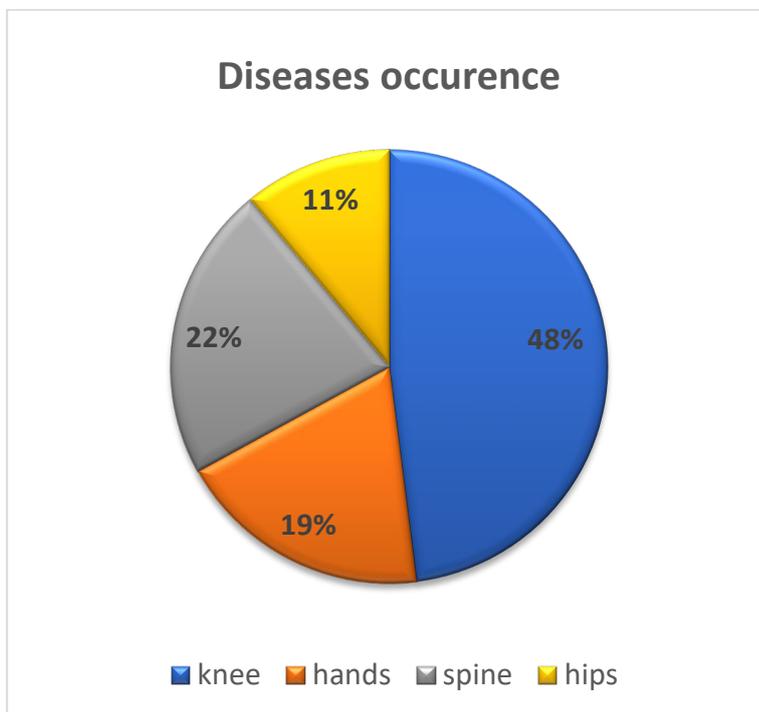

Figure 2. Diseases occurrence in different joints.

Biochemical findings showed that the mean serum calcium level was 7.70 ± 1.43 mg/dL, which is below the normal reference range (8.5-10.5 mg/dL), indicating a tendency toward hypocalcaemia among the osteoarthritis patients. In contrast, the mean ALP level was elevated at 340.04 ± 193.12 IU/L, well above the normal range (45-180 IU/L), suggesting increased bone turnover or metabolic activity commonly associated with joint degeneration. These variations in calcium levels among the study participants are also visually depicted in **Figure 3 and 4**, which highlights the overall reduction in serum calcium across the patient group.
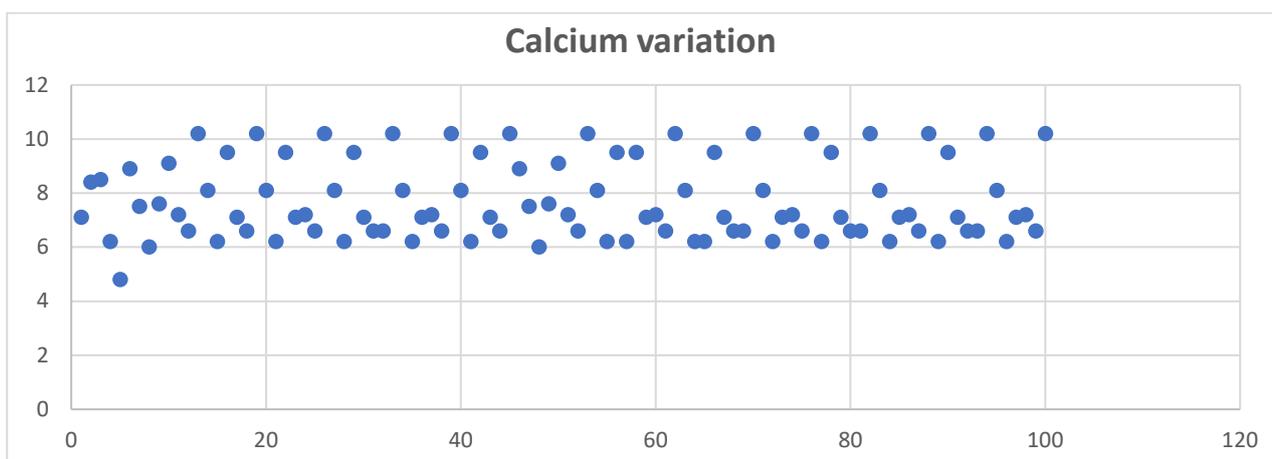

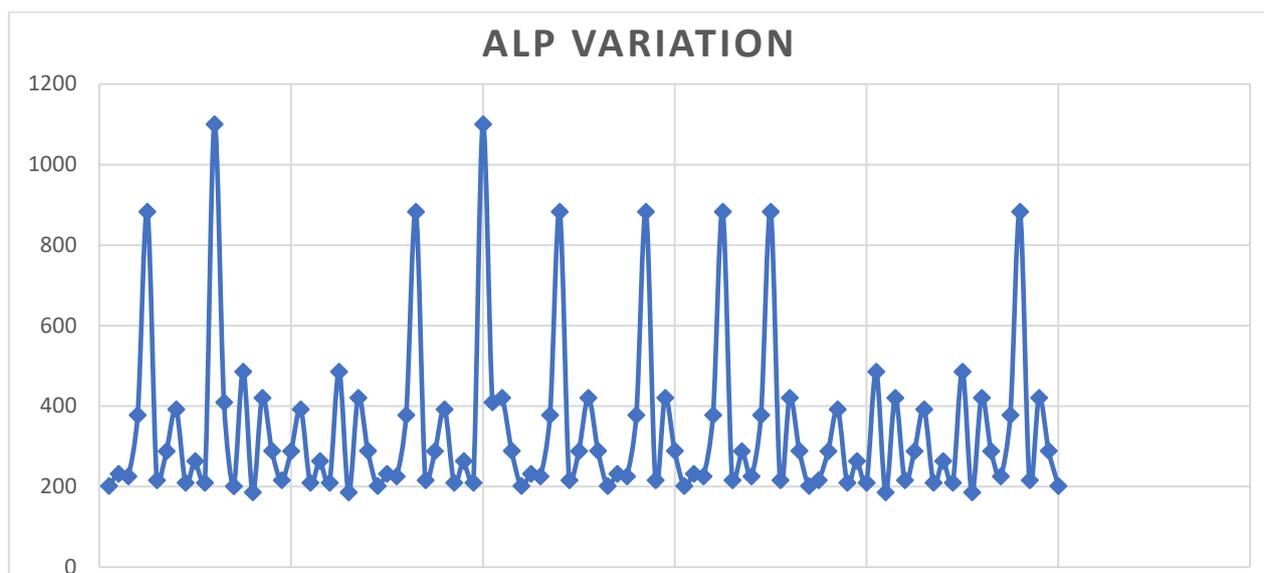**Figure 3.** Calcium variation in osteoarthritis patients.

Figure 4. Alkaline phosphatase variations in osteoarthritis patients.

Discussion

Osteoarthritis is a progressive degenerative joint disorder that is frequently associated with biochemical alterations reflecting underlying metabolic and inflammatory changes. Among the commonly evaluated biochemical markers, serum alkaline phosphatase and serum calcium play an important role in understanding bone turnover, cartilage degradation, and systemic metabolic involvement in osteoarthritic patients. Interpreting variations in these markers can therefore provide valuable insight into disease progression and its physiological impact (Yazmalar et al., 2013).

In this study, a total of 100 osteoarthritis patients were enrolled from the Government Teaching Hospital Shahdara (GTHS) after obtaining informed consent. Blood samples were collected using sterile disposable syringes and transferred into heparinized chemistry vials. The samples were centrifuged at 3000 rpm for five minutes to obtain serum, which was then analyzed using the Selectra Pro M chemistry analyzer to determine serum alkaline phosphatase and serum calcium levels. Standard reference ranges were used for comparison, with normal alkaline phosphatase defined as 45–180 IU/L and normal calcium as 8.5–10.5 mg/dL. Statistical analysis was conducted using SPSS version 20. Mean ± SD was calculated for quantitative variables, including age, while correlation coefficients were applied to assess associations between biochemical parameters. The following discussion interprets these findings in relation to existing evidence and explores their potential implications in osteoarthritis pathology.

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) (Park et al., 2020). 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) (Seo et al., 2019; Webber et al., 2010).

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 (Hunter, 2014). 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 (Poddar et al., 2016). 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 (Sharma, 2018).

There were many studies on relation of osteoarthritis with calcium but there were no relation found with them (Yazmalar et al., 2013). 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 (Salem et al., 2013). Research experiment shows that calcium is involved in the transportation of secretory protein outside the cell. Another study shows that calcium present in blood maybe involve in calcium homeostasis (Amin et al., 2009). Above studies tell us that calcium participate 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 (Salem et al., 2013). Our study shows a negative correlation between serum calcium and serum alkaline phosphatase in osteoarthritis patients.

Conclusion

This study demonstrates a significant inverse relationship between serum alkaline phosphatase and serum calcium levels in patients with osteoarthritis, suggesting a biochemical imbalance associated with disease progression. Elevated alkaline phosphatase levels, alongside reduced calcium concentrations, may reflect increased bone turnover and cartilage degradation typically observed in osteoarthritic pathology. The findings highlight the potential utility of these routine biochemical parameters as inexpensive and accessible markers for assessing disease severity. Incorporating alkaline phosphatase and calcium evaluation into clinical assessment may therefore support early detection and improved monitoring of osteoarthritis. Further research with larger cohorts and additional biomarkers is recommended to strengthen these observations and enhance diagnostic reliability.

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