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The effect of calcium supplements on troponin variables in athletes and their association with bone diseases : Implications for myocardial health

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ABSTRACT: Calcium supplements are commonly used by athletes, and they are also used to treat certain bone ailments, however their cardiovascular safety is still debated. This study was designed to investigate the effect of calcium supplements on troponin variables in athletes as well as those with bone diseases. The current study is case control research included 180 participants (60 patients with bone problems, 60 athletes who use calcium supplements, and 60 healthy control subjects who do not take calcium supplements) and the levels of calcium and troponin measured for all subjected group. The results showed that serum calcium levels in athlete's participants were significantly higher than patients with bone diseases and healthy control subjects respectively (10.13 ± 1.2 vs 9.62 ± 0.92 and 8.57± 0.64, respectively). Also, the calcium levels in patients with bone diseases was significantly higher than healthy control subjects P< 0.001). Serum Troponine concentrations in patients with bone diseasesi and athletes participants were significantly higher than controls (0.22 ± 0.07 and 0.21 ± 0.07 vs 0.06 ± 0.01, respectively, P<0.001). Results showed that the Troponin levels correlate directly with serum calcium among study group which might be referred to that this condition enhances production of Troponin in relation to serum calcium which in turn affected by the calcium supplement administered that linked to a higher risk of myocardial infarction which lead to conclude that it is important to utilize calcium supplements sparingly and aim to get the majority of the necessary daily intake of calcium from food sources.

KEYWORDS: Cardiac troponin; bone; calcium supplements; myocardium.

1. INTRODUCTION

Calcium intake is mostly regarded for its role in enhancing bone health. Calcium supplementation is believed to mitigate age-related bone deterioration and decrease the likelihood of fractures at susceptible locations in middle-aged individuals [1]. Calcium plays numerous vital roles in physiology and disease. Numerous cells, including the parathyroid and renal tubule, among others, have calcium-sensing receptors, and there is evidence that the amounts of calcium ions in the extracellular fluid have a direct impact on how these cells function, which in turn affects how well all excitable tissues work, especially the heart and nervous system [2]. Calcium has an important role in muscular contraction, notably in the myocardium. Previously, depolarization resulted in transitory Ca_2^+ release from SR. As sarcoplasmic (Ca_2^+) increases, Ca_2^+ binds to TnC [3]. Tropomyosin typically sterically inhibits the interaction of myosin heads with actin. The troponin complex regulates tropomyosin activity in skeletal muscle, and as TnC saturates with Ca_2^+, it reverses tropomyosin inhibition of myosin binding to actin [4].

Troponins are structural proteins located in the troponin complex of thin filaments in skeletal and cardiac muscle. The troponin complex comprises three subunits (I, T, and C) and, in conjunction with

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calcium ions, is crucial for the regulation of muscle contraction [5]. Each protein plays a distinct role in muscle contraction: troponin T connects the troponin complex to the actin filament, troponin C serves as the calcium binding site, and troponin I prevents contact with myosin heads when calcium ions are insufficient [6, 7]. Troponin C is produced in both skeletal and cardiac muscles, whereas troponin T and I are predominantly found in the heart, hence termed cardiac troponin (cTnI and cTnT) [7, 8].

The majority of troponin exists within the troponin complex of the cardiac sarcomere, with only approximately 5% present freely in the cytoplasm. This distribution indicates that, in the event of cardiac injury, there is an initial fast release from the cytoplasm, followed by a progressive release of structural origin complexes [5]. The biphasic release pattern is crucial for diagnosing myocardial infarction [7].

Components for Ca_2^+ binding (cardiac troponin C; cTnC), contraction inhibition (cardiac troponin I; cTn]), and tropomyosin binding (cardiac troponin T; cTnT) are all found in the heterotrimeric complex known as cardiac troponin (cTn) [8, 9]. Before a sequence of structural alterations in the thin filament (TF) lead to a force-generating interaction between the actin filament and myosin heads, Ca_2^+ binding to site II of cTnC is the first step [10]. The essential process that initiates contraction is the binding of Ca_2^+ to troponin C. As previously mentioned, depolarization causes SR's temporary Ca_2^+ release [11, 12]. Arctoplasmic (Ca_2^+]) rises, and Ca_2^+ attaches itself to TnC. Actin and myosin heads generally interact sterically when tropomyosin is present. In skeletal muscle, the troponin complex regulates tropomyosin behaviour. When TnC saturates with Ca_2^+, it reverses the inhibition of myosin binding to actin by tropomyosin [4].

This study was designed to investigate the effect of calcium supplements on troponin variables in athletes as well as those with bone diseases.

2. RESULTS AND DISCUSSION

2.1. Characteristics of the study population

Sixty patients with bone disorders, sixty athletes, and sixty healthy controls made up the 180 participants in the current study. Table 1 displays the demographic characteristics of the participants. Age-wise, the mean age of athletes was 48.81 ± 5.76 years, the mean age of patients with bone illnesses was 48.76 ± 6.60 years, and the mean age of control subjects was 50.93 ± 6.83 years. There was no statistically significant difference between the groups (P = 0.211). The three groups' serum levels of calcium and troponine differed significantly (P-value < 0.001 for both parameters). Table 1 lists the laboratory tests that are performed..

Table 1. Characteristics of all participants

Characteristic	Bone diseases patients (n=60)	Athletes participants (n=60)	Healthy Control (n=60)	*P*
Age (years)	48.76 ±6.60	48.81 ± 5.76	50.93± 6.83	0.211
Calcium level	9.62 ± 0.92^A	10.13 ± 1.2^B	8.57 ± 0.64^C	< 0.001
Serum Troponin level	0.22 ± 0.07^A	0.21 ± 0.07^A	0.06 ± 0.01^B	< 0.001

Different letters denote to the significant differences at p < 0.05.

2.2. Measurements of Serum Calcium and Troponin level

Serum calcium levels in athletes were significantly higher (10.13 ± 1.2 vs. 9.62 ± 0.92 and 8.57 ± 0.64, respectively) than in patients with bone diseases and in participants in good health. As illustrated in Figure 1, those with bone disorders also had significantly higher calcium levels than healthy control subjects (P<0.001). These findings are consistent with two different studies [2, 13] which discovered a correlation between increased blood calcium levels and increased supplement calcium levels [14]. Sportsmen's serum calcium levels (10.13 ± 1.2 vs. 9.62 ± 0.92 and 8.57 ± 0.64, respectively) were significantly greater than those of patients suffering from bone diseases and healthy individuals. Furthermore, as seen in Figure 1, those with bone issues had significantly higher calcium levels than healthy control subjects (P<0.001). These findings are consistent with two different studies [15] that discovered an increase in supplement calcium was linked to greater blood calcium levels [16]. The reports indicate a statistically significant increase in adverse cardiovascular events following calcium supplementation; however, a number of experts have questioned

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the validity of the data because of inconsistent attempts to replicate the findings in other populations, low compliance, biases in case ascertainment, and/or a lack of adjustment [17, 18].

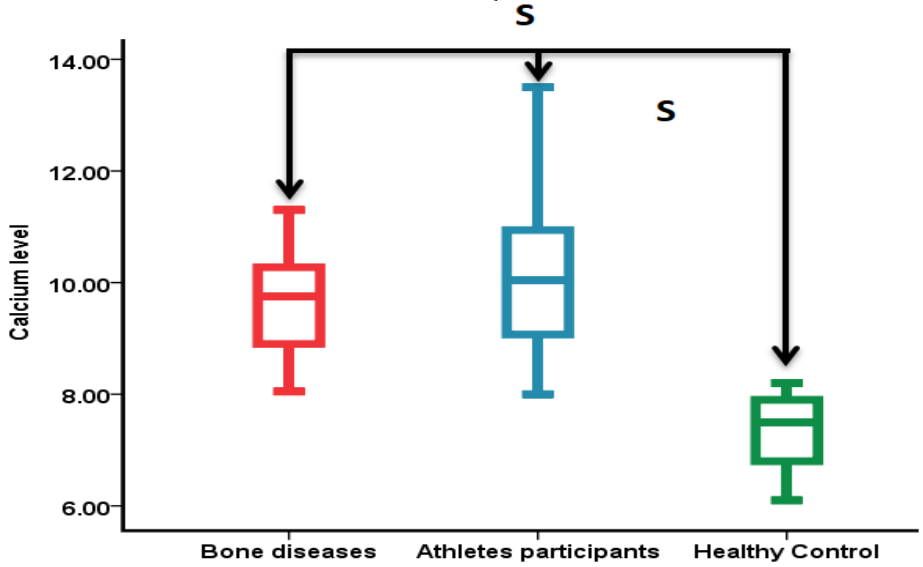

Figure 1. serum calcium levels in patients with bone diseases, athletes participants and healthy control. S: statistically significant P < 0.05.

Figure 2 shows that the serum troponine concentrations in athletes and patients with bone disorders were considerably greater than those in healthy control subjects (0.22 ± 0.07 and 0.21 ± 0.07 vs. 0.06 ± 0.01, respectively, P>0.001). These findings suggest that consuming calcium supplements raises blood calcium levels, which in turn raises blood troponin variables and poses a serious risk to heart health. These findings align with several previous studies [19].

This presents a dilemma for anyone thinking about taking or recommending calcium supplements. growing data of increased cardiovascular risk. This equilibrium was evaluated in the meta-analysis conducted by Bolland et al., on calcium monotherapy, which found that administering calcium supplements to 1000 individuals for five years would result in an additional 14 myocardial infarctions, 10 strokes, 13 fatalities, and 26 fracture avoidances [20]. Another study conducted by KALT reported that Although the absolute values are lower in younger participants, the balance is still negative [21]. Therefore, the information that is now available indicates that the widespread use of calcium supplements by older people is counterproductive and ought to be discontinued [22, 23].

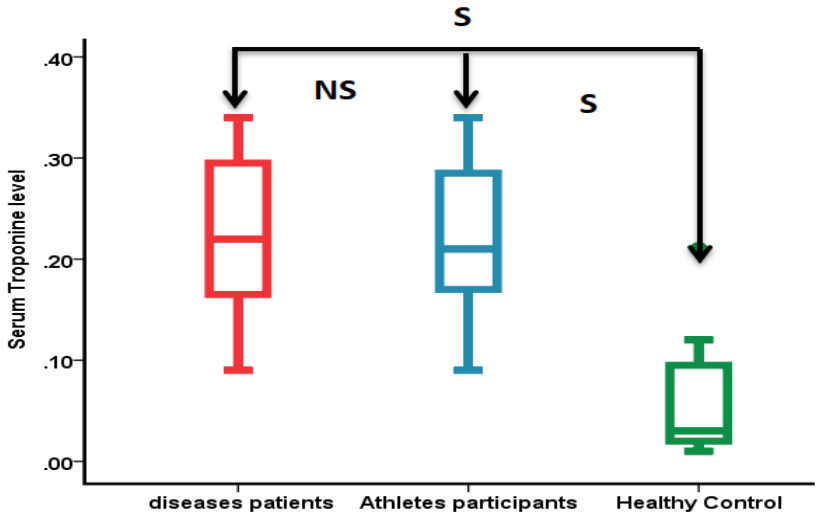

Figure 2. serum level of Troponin in patients with bone diseases, athletes participants and healthy control. NS: Not statistically significant, S: statistically significant P < 0.05.

2.3. Logistic regression correlations between Troponin and calcium.

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As seen in Figure 3, the logistic regression model demonstrates that there is a direct association between the study group's serum calcium and troponine levels. This finding may indicate that the condition increases the production of troponine in relation to serum calcium. This implies a connection between troponin levels and calcium. These results were consistent with previous research which suggests that elevated calcium levels cause athletes who use calcium supplements excessively or inappropriately to have elevated troponin levels, which in turn impacts the health of the heart muscle [17].

We still need more research to fully understand how calcium supplements affect cardiovascular disease risk, and the negative cardiovascular consequences several studies have reported now lack sufficient evidence. Although the exact underlying mechanisms are yet unknown, circulating calcium is a risk factor for vascular disease. This result is supported by research using Mendelian randomization and large observational populations [24].

levels by a quantity that, several hours after each dosage, is linked to a clinically substantial increase in risk. Before extrapolating the results of a limited number of studies, demographic-specific data from participants of different ages, genders, ethnicities, and risk profiles worldwide must be gathered in the future. This suggests a relationship between calcium and troponin levels.According to Shin et al., these findings support the theory that athletes who misuse or overuse calcium supplements have higher troponin levels, which subsequently jeopardizes the healthy function of the heart muscle [17].

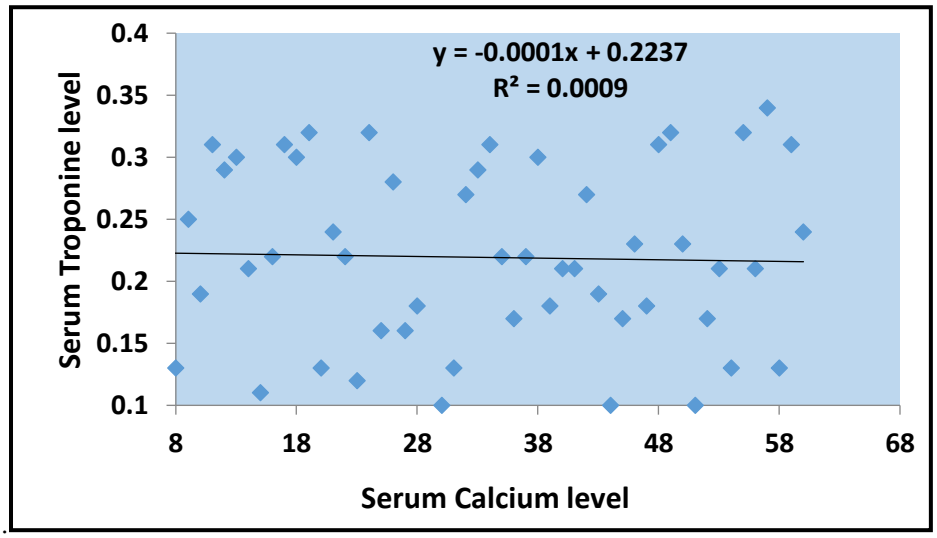

Figure 3. The Logestic scatter blot of Troponin and calcium among study group.

3. CONCLUSION

It was concluded from the result of the current study indicated a relationship between calcium and troponin levels. This means that if calcium levels increase, this leads to an increase in troponin levels in athletes who use calcium supplements in large quantities or incorrectly, and this affects the health of the heart muscle. Results also showed that circulating calcium has been linked to vascular disease, although the exact mechanisms are unknown and need scientific proof and this conclusion insist the importance of controlling the calcium intake in athletes

5. MATERIALS AND METHODS

5.1. Study design

The present study is case control research that conducted on 180 participants (60 patients with bone diseases, 60 athlete's participants use calcium supplements and 60 healthy control who do not take calcium supplements) who were recruited from several hospitals and sports clubs (Gyms) in Baghdad province.

The control group was selected to match the age, gender, and BMI of the participants in the current study, aiming to prevent any influence from these factors on the levels of the markers under investigation.

5.2. Sample collection and preparation

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Five milliliters of blood samples were collected from fasting patients and controls at 9-11 AM and the sample put into serum separating tube (SST) to obtained the serum that used to evaluate the Calcium in human serum quantitatively using the calcium test kit. Using the DRI-CHEM NX500Dry chemistry analyzer from FUJIFILM with the manufacturer's instructions. Troponin in human serum was quantitatively determined using the troponin test kit. Using the Cobas e411 immunoassay analyzers with the Electrochemiluminescence Immunoassay ("ECLIA") technique in accordance with the manufacturer's instructions.

5.3. Permissions and Ethical Consideration

The necessary permissions were acquired from the Thi Qar Health Office - Research Committee (Thi-Qar), The patients' consent was sought in order to perform the interview and gather the samples. Patients orally consented to participate in the study after being told of its purpose prior to any sample collection or interview process.

5.4. Statistical Analysis

Statistical analysis was performed using SPSS software version 20. The data were evaluated for normality, and the Shapiro-Wilk test validated its normal distribution. Results were presented as mean ± standard deviation (SD). A one-way ANOVA with a Least Significant Difference (LSD) post hoc test was performed to assess significant differences among means resulting from multiple comparisons. A P value below 0.05 was considered statistically significant [25, 26].

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