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A Comparative Study of Measured and Calculated Ionized Calcium in Plasma

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Abstract: ***Calcium as a nutrient is most commonly associated with the formation and metabolism of Bone. Over 99 percent of total Body calcium is found as calcium hydroxyapatite. Ionized calcium is measured by ion selective electrodes. It is also calculated from albumin and globulin values using an appropriate formula. In this study was we will compare measured and calculated ionized calcium in plasma. Material and method : The comparative descriptive study was conducted in Department of Biochemistry of Guru Gobind Singh Medical College and Hospital, Faridkot. 50 patients of arterial blood were enrolled for study. Result: A total of 50 simultaneous arterial blood samples were obtained from 50 patients. Mean age of 45.52±17.45 years and range 18-84 years. Maximum numbers (40%) of patients were from the age group of 34-50 years followed by (24%) in the age group of 18 - 33 years A statistically significant correlation was found between measured and ionized calcium with p value 0.002 and r value 0.418. The difference between measured and Calculated ionized calcium was 0.24mmol/l with p value <0.001 (95% CI of 0.17 – 0.30) which was statistically highly significant. Conclusion; The values of measured and calculated ionized calcium are correlated but there is significant difference in their mean value. Moreover calculated calcium shows significant correlation with total protein and albumin so it is not a reliable indicator in conditions where protein levels are altered.***
Keywords: Total calcium, Ionized calcium, serum albumin, total protein.

ABBREVIATIONS; iCa – Ionized calcium
caT – Total calcium
ISE – Ion selective electrode
PTH – Parathyroid hormone

I. INTRODUCTION

Calcium is the fifth most abundant element in the human body, with 1000 g present in adults. It plays a key role in skeletal mineralization, as well as a wide range of biologic functions. Calcium is an essential element that is only available to the body through dietary sources. Current dietary calcium recommendations range from 1000 to 1500 mg/dl, depending on age.[1] Calcium requirement is dependent on the state of calcium metabolism, which is regulated by three main mechanisms: intestinal absorption, renal reabsorption, and bone turnover.[2]

Serum calcium ranges from 8.5 to 10.6 mg/dl in healthy subjects. It comprises free ions (45%), protein-bound complexes (45%), and ionic complexes (10%).[3] (Figure – 1).

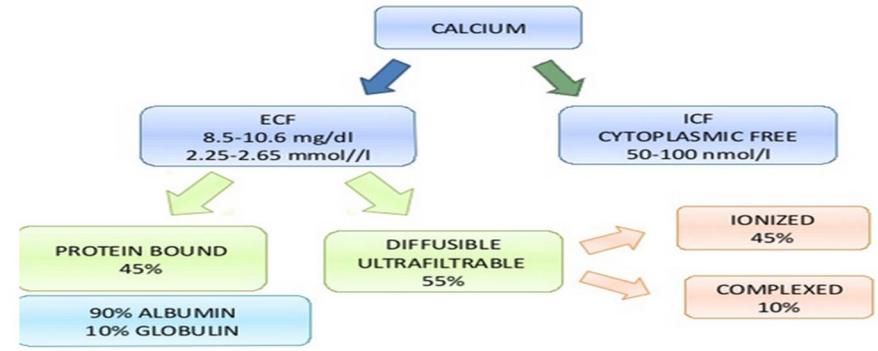


Figure ! – Distribution of calcium in body

To avoid calcium toxicity, the concentration of serum ionized calcium is tightly maintained within a physiologic range of 4.4 to 5.4 mg/d.[4] In our country, malnutrition is quite a common problem, thereby influencing total protein concentration including albumin. The measured total calcium value is affected by total protein concentration particularly albumin. So in this scenario, false low calcium levels may be reported.[5].

iCa measurement is not routinely available and in some instances, may require additional costs for measuring and reporting. Besides, iCa values could be altered by some factor. Change in blood pH can alter the equilibrium of the albumin – ionized complex with acidosis reducing binding and alkalosis enhancing it.[6]

So the aim of present study was to compare the measured and calculated ionized calcium in plasma.

II. MATERIAL AND METHODS

The Study was conducted in Department of Biochemistry of Guru Gobind Singh Medical College and Hospital, Faridkot. Ethical clearance was taken from institutional ethical committee. Proper informed consent was taken from all the participitants.

1ml of Arterial blood was required in heparinized syringe for biochemical investigation. The same blood sample was analyzed for ionized calcium by blood gas analyzer. The blood sample was centrifuged at 3000rpm for 10 minutes to separate plasma. The plasma was used for estimation of CaT by OCPC method and protein by Biuret method & Albumin by BCG method.

Formulas to calculate ionized calcium[7]

1) % protein bound calcium = 0.8 × albumin(g/L) + 0.2 × globulin(g/L) +3
2) Calculated iCa (mg/dl) = CaT - Protein bound calcium
3) Calculated iCa(mmol/L) = Calculated iCa (mg/dl) × 0.25

Statistical analysis was done by IBM(R) SPSS(R) V.20.00 software.

III. RESULTS AND OBSERVATIONS:

A total number of 50 samples were obtained, 42% were males and 58% were females.

Table1; Showing Age Distribution of Patients

Age(Years)	Total(N)	Percentage
18-33	12	24.0
34-50	20	40.0
51-67	11	22.0
68-84	07	14.0
Total	50	100.0

Table 1 showing the age distribution of patients with mean age of 45.52±17.45 years and range 18-84 years. Maximum numbers (40%) of patients were from the age group of 34-50 years followed by (24%) in the age group of 18 - 33 years.

Figure 2: Correlation between measured and calculated ionized calcium;

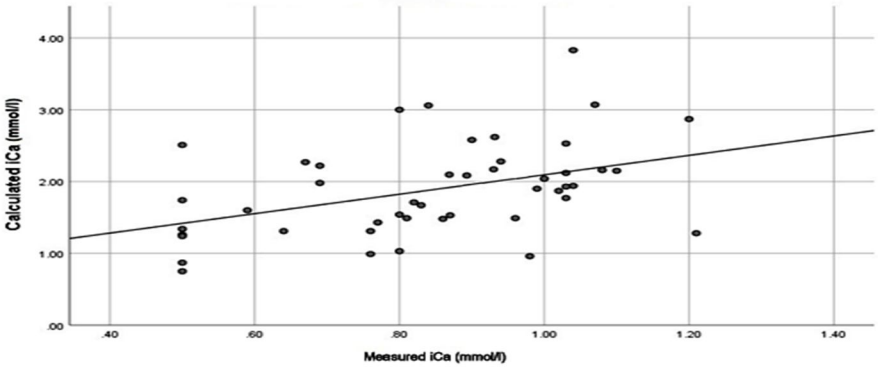
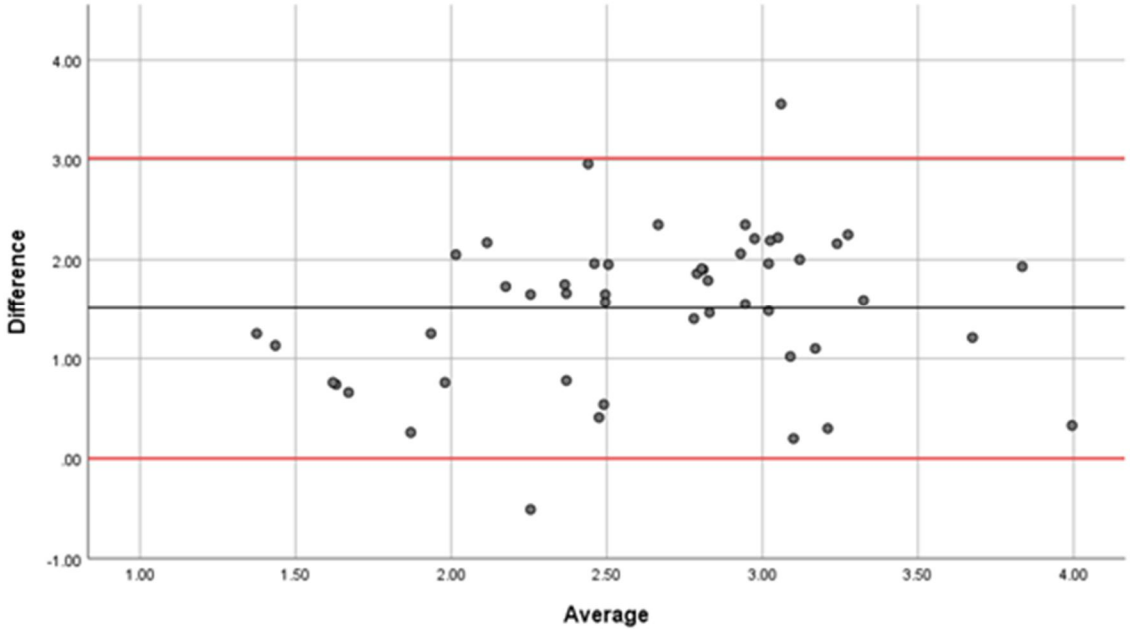


Figure 3: Difference between measured ionized calcium and Calculated ionized calcium.



IV. DISCUSSION

Calcium is an essential mineral in the human body, involved in several important metabolic processes, such as blood clotting, muscle excitability and contraction, transmission of nerve impulses, enzyme activation, second messenger formation and hormone secretion, with the main feature of mineralization of bone and teeth.[8] The mean age of study group (as shown in table 1) showed the maximum number 40 of patients were from the age group of 34-50 years. Mean age of patients was45.52-17.45years.out of 50 patients included in the study, there were 21 males and 29 females giving a male to female ratio of 1:1.4 The Measured total calcium with a mean value of 7.44±0.67mg/dl. Measured ionized calcium has mean value of 0.90 ± 0.19mmol/l. Protein bound total calcium had mean value of 5.55±0.56g/dl. Calculated ionized calcium had mean value of 1.14±0.15mmol/l. Total plasma protein had mean value of 5.61±0.95g/dl. Plasma albumin had mean value of 2.40±0.70g/dl. Plasma globulin had mean value of 3.28±0.79g/dl. pH had mean value of 7.42±0.11.The correlation between measured and calculated ionized calcium was 0.418 with p value 0.002 which was statistically significant.

The correlation between calculated ionized calcium and biochemical parameters; measured total calcium was -0.62(p value 0.001) which was statistically highly significant, protein bound calcium was 0.30 (p value 0.020), total plasma protein was -0.36 (p value 0.008) and plasma albumin was -0.30 (p value 0.02). They were statistically significant where as the correlation between calculated ionized calcium and plasma globulin was 0.18 (p value 0.20) and pH was -0.108 (p value 0.455). They were statistically non-significant.

The correlation between ionized calcium and biochemical parameter; measured total calcium was -0.43 (p value 0.001) which was statistically highly significant, Protein bound calcium was 0.071 (p value 0.622), total plasma protein was 0.002 (p value 0.98), plasma albumin was 0.07 (p value 0.615), plasma globulin was 0.06 (p value 0.66). They were statistically non-significant and pH was -0.366 (p value 0.008) which was statistically significant.

Mean difference between measured and calculated ionized calcium was 0.24 mmol/l with p value <0.001 (95% CI 0.17-0.30) which was highly significant.

In a study of Measured free calcium and calculated free calcium as obtained by formulae were compared using paired *t*-test. It is observed that when all samples are considered together, calculated free calcium obtained by using all three formulae show significant differences from measured free calcium values. When individual subgroups are considered based on their albumin concentrations, a similar picture evolved in patients with hypoalbuminemia. However, in patients with albumin levels with in the reference range used by the laboratory (i.e., 35–52 g/L) calculated free calcium obtained using showed no significant difference with measured free calcium by direct ISE. In the hyperalbuminemia group, calculated free calcium obtained using formula did not show significant difference from measured free calcium. [9]

V. CONCLUSION

The values of measured and calculated ionized calcium are correlated but there is significant difference in their mean value. Moreover calculated calcium shows significant correlation with total protein and albumin so it is not a reliable indicator in conditions where protein levels are altered.

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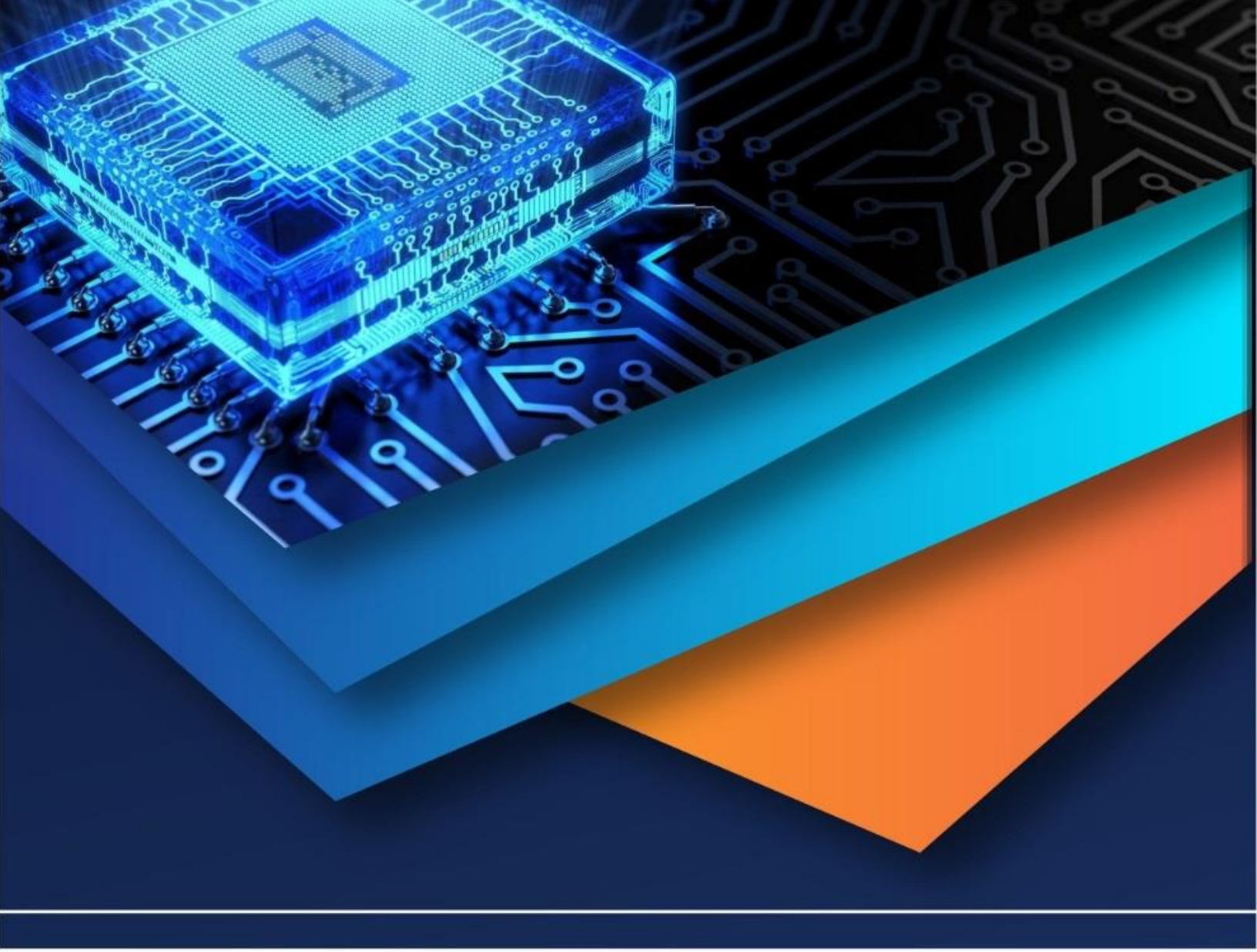

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