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## Relationship Between Calcium and Phosphorus in Serum & CSF in Geriatric Patients

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### *Abstract*

Serum and cerebrospinal fluid (CSF) levels of calcium (Ca) and phosphorus (Pi) were estimated in both geriatric controls and dementia patients to evaluate the relationship of Ca & Pi in aging and age related disorders. No significant correlation was observed between serum and CSF Ca ( $r < 0.2$ ) or Pi ( $r < 0.22$ ) either in geriatric controls or patients. However the relationship between Ca and Pi levels in CSF was significant in dementia patients ( $r=0.6851$ ) but not in controls. There was no significant correlation between Ca & Pi levels in serum either in geriatric controls ( $r=0.2388$ ) or in patients ( $r=0.2127$ ).

Both Ca ( $F=4.944$ ,  $P < 0.001$ ) and Pi ( $F=4.6682$ ,  $P < 0.001$ ) levels in CSF were significantly decreased in dementia patients when compared to geriatric controls. However serum levels of both Ca and Pi were not significantly different from that of controls. The low CSF levels of Ca along with decreased Pi levels noted in this study might be due to early deposition of Ca in brain and not due to alterations in serum levels. These alterations noted only in CSF might show some etiological disturbances in dementia with reference to Ca & Pi levels in CSF.

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Key words -

**Dementia,**  
**Geriatric,**  
**CSF,**  
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**Dementia,**  
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**CSF,**  
**Calcium,**  
**Phosphorous,**  
**Serum**

The involvement of trace elements in understanding the etiopathogenesis of certain age related disorders, especially dementia has been discussed by many workers [1]. There is a substantial published literature on the blood concentration of trace metals in various diseases including dementia [2], [3], [4], [5] but relatively little information is available on cerebrospinal fluid (CSF) levels. Though calcium (Ca), one of the important elements involved in many biochemical functions, has been studied in various neurological disorders [4], the relationship between calcium and phosphorus (Pi) in serum and CSF has not been studied so extensively. It has been reported that the alterations in Ca and Pi levels in CSF will reflect the overall changes in brain concentration [6]. Like in blood, the balance in Ca-Pi product is essential in CSF also. An increase or decrease in either of the elements in CSF would result in alteration in the product which might predispose either to disposition or sequestration of Ca in brain. Such a process may interfere with the normal brain function and might affect central nervous system processes like memory, neural transmission and protein synthesis among others. This may eventually lead to disease processes like dementia. This present study was undertaken to evaluate the relationship of Ca and Pi levels in serum and CSF in geriatric controls and dementia.

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## Material and Methods

The study group consisted of 65 patients with dementia (mean age 58.6 years). Out of these, 40 patients fulfilled the DSM III criteria [7] for Alzheimer's disease (AD) and 25 for multiinfarct dementia (MID) by Hachinski's criteria [8]. The diagnosis was further confirmed by CAT scan and neuropsychological assessment. 20 geriatric subjects (mean age 50.7) who had no neurological problems formed the control group. Blood and CSF were simultaneously collected from patients and controls. CSF was obtained from controls who underwent surgery under spinal anaesthesia for various systemic disorders.

Serum and CSF Ca was estimated spectrophotometrically by using O'Cresophthalein method [9]. Phosphorus was assayed spectrophotometrically by the molybdate method [10]. The analysis was performed on Hitachi 705 autoanalyzer using specific calibrators and controls for both the constituents. Statistical analysis of the data was done by using ANOVA (analysis of variance). Values of  $p < 0.05$  was considered to be significant.

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## Results

It is observed from figure 1 that CSF Ca levels remained almost constant despite variations in blood levels (5-10 mgs%) and that there is no significant correlation ( $r < 0.2$ ) between serum and CSF Ca both in controls and patients. However, a significant decrease in CSF Ca ( $p < 0.001$ ) was noted in patients when compared to controls (Figure 1). Similar observation was noted in Pi levels. The concentration of Pi in CSF changed marginally when compared to wide variations in serum levels. There was no significant correlation between serum and CSF levels of Pi either in controls ( $r=0.1575$ ,  $p > 0.05$ ) or in patients ( $r=0.2270$ ,  $p > 0.05$ ). However Pi levels in CSF were found to be significantly reduced ( $p < 0.001$ ) in patients. The relationship between Ca and Pi levels in CSF was significant in dementia patients ( $r=0.6851$ ,  $p < 0.001$ ) (Figure 2) but not in controls ( $r=0.2810$ ,  $p > 0.05$ ) (Figure 3) whereas Ca and Pi levels in serum did not correlate significantly either in controls ( $r=0.2388$ ,  $p > 0.05$ ) or in patients ( $r=0.2127$ ,  $p > 0.05$ ).

*•Serum and CSF calcium levels in controls and patients*

*•The relationship between CSF calcium and CSF phosphorus levels in patients*

### ***.The relationship between CSF calcium and CSF phosphorus in controls***

The decrease in CSF Ca (Table 1) was significant in dementia group (F 2, 83=4.9444, p < 0.001) when compared to controls. Similarly Pi levels were also significantly reduced in dementia patients (F 2, 83=4.6682, p < 0.001). There was no significant difference in serum and CSF levels of either Ca or Pi between the AD and MID groups.

### ***Table I - Serum and CSF levels of calcium and phosphorus in geriatric controls and dementia***

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Values are mean  $\pm$  SD

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## **Discussion**

The electrolyte concentration of brain usually remains unchanged despite wide variations in serum concentration. This is mainly taken care by the presence of blood-brain and blood-CSF barrier [11]. Ca is one such element wherein marginal changes in brain are noted when compared to wide variation of serum Ca. The concentration of Ca among other metals in intracellular fluid is reported to be similar to that of CSF [12]. Apart from various physiological conditions, changes in Mg levels in body fluids have also been reported to affect the Ca-Pi pool [13]. Normally the concentration of Ca in CSF is similar to that of serum ultrafiltrate and the ionic Ca in CSF accounts for nearly 50-60% of total Ca [6]. In this study, it is observed that CSF Ca is significantly decreased in dementia without much change in serum levels. This decrease, only in CSF, altered the serum-CSF ratio significantly in patients. Normally, the serum-CSF ratio of Ca is reported to be around 2 [4], [6]. The geriatric controls in our study showed a ratio of 2.75. When compared to this, patients showed a significantly increased ratio (4.75). This depletion of CSF Ca in patients, probably, may be due to early deposition of Ca in the brain or due to cellular sequestration. Normally, the Ca-Pi pool is maintained whenever there is a change in Ca levels. Interestingly in this study, Pi levels in CSF also showed a significant decrease in patients when compared to controls, without a significant change in serum. Consequently, the serum-CSF ratio of Pi is significantly elevated. The low CSF Ca levels along with decreased Pi noted in this study may be due to early deposition of Ca in brain and not due to decreased serum levels as there is no significant correlation between serum and CSF levels of Ca. The relationship between Ca and Pi levels in serum was also not significant in both controls and patients. However the CSF levels of Ca and Pi showed a significant correlation only in patients. This observation shows that the Ca-Pi pool is maintained even at low levels of both the constituents. It may be anticipated that, for all practical purposes, the concentration of either Ca or Pi in CSF or the serum/CSF ratio will be complex in a given situation and a very strong correlation between serum and CSF will generally not be found. However, correlation between Ca and Pi in CSF is found to be significant in patients in spite of decreased levels. This significant observation might be related to the findings of abnormal accumulation of insoluble compounds like hydroxy apatites in neurones in such cases. These alterations noted in CSF might also show some etiopathogenic disturbances in dementia with relation to the CSF levels of Ca and Pi, which is a reflection of brain levels.

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