CALCIUM METABOLISM NORMAL AND ABNORMAL HORMONAL CONTROL

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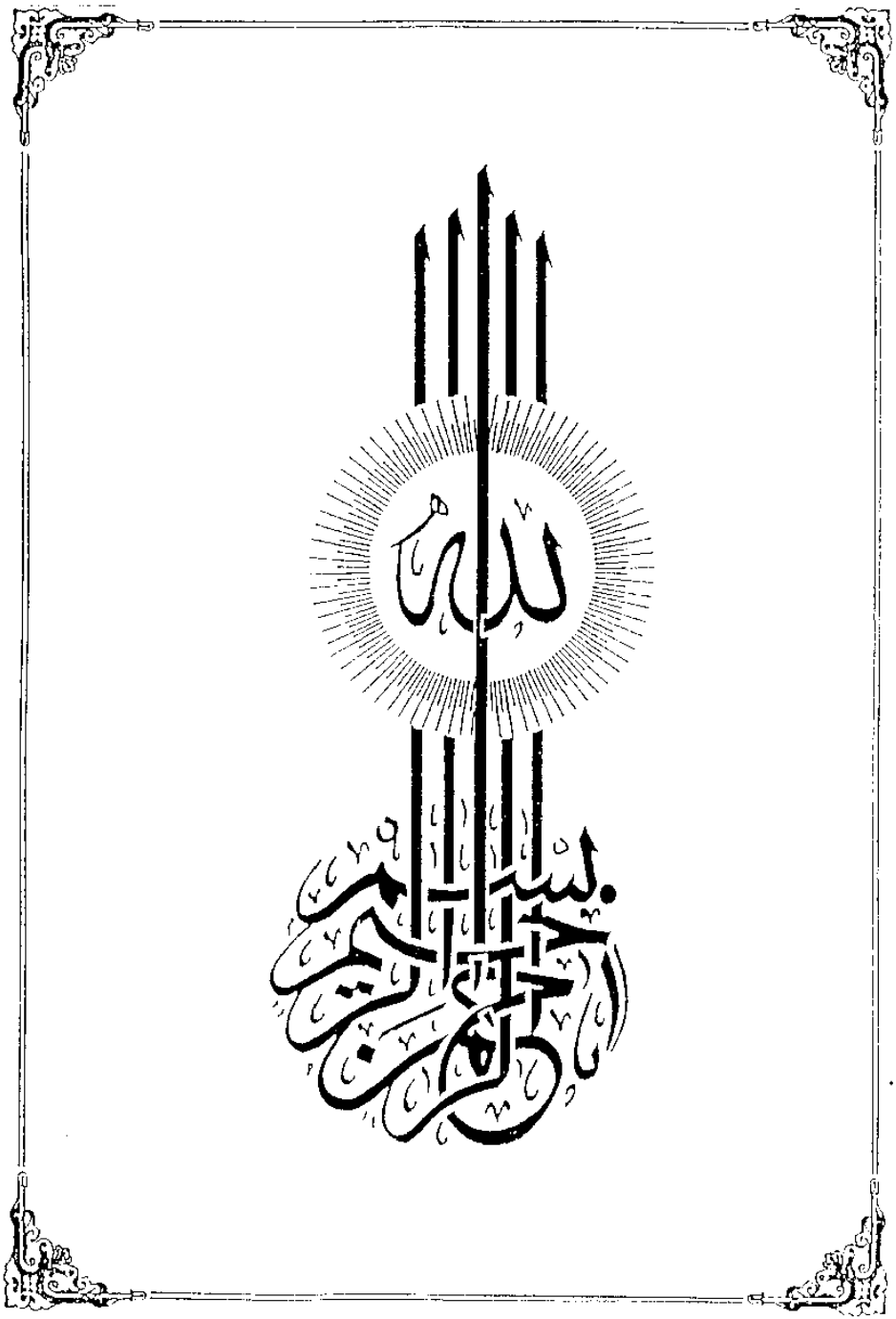

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INTRODUCTION

The mineral elements present in the body are classified as principal elements and trace elements. There are 7 principal minerals: calcium, magneisum, sodium, potassium, phosphorus, sulphur and chloride. These principal elemnts constitute 60-80% of all the inorganic material in the body.

Trace elements occur in the living tissues in small amounts. They are subdivided into 3 groups: essential, possibly essential and non essential according to their dietary requirements.

Metabolic actions of calcium

Calcium is required for bones and teeth formation and it is essential for growth. It decreases capillary and cell membrane permeability and it is also essential for the excitability for muscle and nerve cells. Calcium is also essential for secretion of certain hormones as ADH and catecholamine, normal transmission of nerve impulse, muscle contractions and for activation of certain enzymes as lipase, adenosine triphosphate, succinic dehydrogenase and protease.

In particular, calcium is essential for cardiac rhythmicity, blood coagulation and formation of intercellular cement substance.

of hydrogen ion concentration. It also helps in regulation of hydrogen ion concentratin in blood.

As regard the distribution of phosphorus, about 80% of the phosphorus in the body is combined with calcium in bones and teeth, 10% is in combination with lipids, carbohydrates and proteins and in other compounds in blood and muscles, and the remaining 10% of phosphorus is widely distributed in various chemical compounds.

The adult person of about 70 K.g. contains in his body about 600 grams of phosphate and in plasma, inorganic phosphate concentration is about 5-6 m.g/100 m.l.

Phosphorus is present in nearby all foods conseq-uently a dietary defeciency is not known to occur in man. The avarage daily intake of phosphate is about 1.5 grams for adults.

ABSORPTION OF CALCIUM

Digestion and availability of calcium

A large proportion of calcium, in most foods, exists in bound forms and thus digestion is required to liberate calcium as an essential preliminary to absorption. For calcium to be absorbed, it must be soluble and ionised.

A variety of factors are known to affect the availability of calcium in the intestine including phosphate, phytic acid and oxalic acid. Also, the bulk of the diet, the amounts of the dietary fat, the formation of calcium soap, bile salts, proteins, amino acids, sugar and calcium / phosphorus ratio in the diet affect the availability of calcium in the intestine **(Smith and Mc Allan 1966).**

Net Calcium absorption

It is the difference between dietary calcium intake and faecal calcium. It can be expressed as an absolute amount or as a percentage of the dietary calcium intake.

Net calcium absorbed is related to calcium intake. At calcium intake below 3 m.g/K.g/day, the

transport capacity per unit length, it has been thought that the duodenum is the major site of calcium absorption. However, the site at which the major part of the dietary calcium is absorbed in vivo depends not only on the effeciency of absorption but also on the length of intestinal segment, the time the food is present in the segment and the concentration of calcium in the lumen **(Wasserman and Taylor 1969)**. The following factors affect calcium absorption.

[A] Hormonal control:

(1) Vitamin D_3

Vitamin D has three effects on calcium absorption: a) accelerates the calcium uptake into the absorptive cells. b) enlarges the pool of calcium within the cells. c) enhances calcium transfer at the basal pole of the absorptive cells **(Wasserman and Taylor 1969)**.

(2) Parathyroid hormone.

There is abundant clinical and experimental evidence that parathyroid hormone promotes intestinal absorption of calcium to increase the serum calcium and lower the plasma phosphate **(Massry et.al. 1982)**.

This effect of parathyroid hormone in promoting calcium absorption correlates with the high calcium absorption usually found in patients with hyperparathyroidism and decreased calcium absorption in hypoparathyroid subjects **(Massry et.al. 1982).**

(3) Calcitonin.

The effects of calcitonin administration on calcium absorption in man are equally varied. **Hico et.al. (1970)** found that the administration of 1 - 2 MRC units / K.g / day for five days to five osteoporotic and two hypercalciuric patients increased calcium absorption.

However **Caniggia et.al. (1968)** found no effects of calcitonin on radiocalcium absorption.

Jejunal intubation studies in 10 normal subjects showed that the intravenous infusion of synthetic salmon calcitonin did not significantly affect calcium absorption **(Gray et.al. 1973).**

Patients with calcitonin secreting medullary carcinoma of the thyroid donot have any constant abnormalities of calcium metabolism including calcium absorption **(Nordin 1973).**

Calcitonin decreases calcium absorption since it blocks the formation of 1,25 $(oH)_2$ D_3 and it also reduces gastric acidity **(Martin 1976).**

(4) Corticosteroids.

Many studies in man indicate that the administration of corticosteriods significantly decrease intestinal calcium absorption **(Kimberg et.al. 1971).**

Glucocorticoids impair absorption of calcium probably by inhibiting the conversion of vitamin D to its active metabolites **(Gallagher et.al. 1973), (Massry et.al. 1982).**

(5) Thyroid hormone.

Although **Taylor (1968)** showed increased calcium absorption in rats given l-thyroxine for 3 days and **Krawitt (1967)** could find no changes in net calcium absorption in l-thyroxine treated rats. Several other workers showed that the administration of l-thyroxine decreases calcium absorption in rats **(Williams et.al. 1967).**

Noble and Matty (1967) found that l-thyroxine decreased both the active and passive movements across the whole small intestine of rats. This decrease

in calcium absorption on the administration of thyroid hormone to animals is paralled by the decreased calcium absorption in the human subjects with hyper-thyroidism.

[B] Anions:

(1) Phosphate.

Calcium / phosphate is an important factor in calcium absorption. Calcium absorption is changed by the amount of inorganic phosphate in the diet. A low level of phosphate increases calcium uptake and the optimal calcium / phosphate ratio for calcium absorption is 1:1.

(2) Fluoride.

Sodium fluoride decreases calcium absorption due to binding of calcium in the intestine and due to inhibition of energy production essential for active transport of calcium **(Spencer et.al. 1969).**

[C] Other dietary components:

(1) Proteins and amino acids.

Early workers found that increasing dietary proteins resulted in an increased absorption of dietary calcium **(Mc Cance et.al. 1942).**

Certain amino acids increase calcium absorption as lysine and arginine due to the formation of soluble chelates. Other amino acdis have this property but the less extent as leucine and methionine (**Massry et.al. 1982**).

(2) **Carbohydrates and sugars**.

Lactose increases the absorption and retension of calcium (**Condon et.al. 1970**). Other sugar as mannose, xylose and raffinose have the same effect like lactose (**Vaughan and Filer 1960**).

Lactose may chelate calcium or may produce non specific inhibitory effect on the energy producing mechanism of the intestinal cells which in turn leads to an increased permeability to calcium (**Wasserman and Taylor 1969**).

(3) **Fats**.

Fatty acids interfer with the absorption of calcium due to the formation of insoluble calcium salts. Also the presence of excess fat in the diet interfers with the absorption of calcium due to the utilization of most of the bile salts and bile acids which are essential for absorption of insoluble calcium salts (**Massry et.al. 1982**).

[D] Miscellaneous factors:

(1) Hydrogen ion concentration.

The p.H of intestinal contents has been suggested to affect calcium absorption.

Calcium salts are soluble in acid solutions and relatively insoluble in alkaline solutions. So, factors which increase intestinal acidity favour the absorption of calcium and vise versa. Absorption of calcium is increased by the presence of lactic and citric acid [but the presence of phytic and oxalic acid decrease the absorption of calcium due to the formation of insoluble calcium phytate and calcium oxalate].

(2) Body needs and concentration of calcium in diet.

The intestinal regulation of calcium absorption in response to physiological needs for calcium is a remarkable efficient homeostatic process. Reduction in efficiency of absorption of oral calcium occurs when calcium intake is high **(Kimberge 1961), (Massry et.al. 1982).**