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Calcium

Ca^{2+} is the fifth most common element & the most prevalent cation.

The body contains 1 kg of Ca^{2+} and it is found in 3 in 3 main compartments: Skeleton (with 99% of Ca^{2+}), soft tissue and ECF (both with 1% of Ca^{2+}).

Function of Ca^{2+} :

1. **Structural** : in bone and teeth .
2. **Neuromuscular** : excitability and muscle contraction .
3. **Enzymatic** : coenzyme for coagulation factors .
- 4- **Signaling** : intracellular second messenger.

Normal range:

8.5 – 10.5 mg/dl (2.15-2.55 mmol / L)

Biochemistry & physiology:

Ca^{2+} exist in 2 main physiochemical states :

1- **Free (ionized):** Which is the **biological active** form and it is tightly regulated in the body.

2- **Bound :** to plasma protein (mainly albumin) , the is the physiologically **inactive from** .

Changes in plasma protein concentration , particularly of albumin , alter the most commonly measured plasma total calcium , but not of the free ionized fraction . The direct measurement of the physiologically active free calcium ionized fraction is confined to special cases.

Interfering Factors :

- 1- **Prolonged tourniquet use and venous occlusion is a common error.** It leads to increased total Ca^{2+} (not the free) due to efflux from the vascular compartment leading to increased protein- bound substances.
- 2- **Vitamin D intoxication** may cause increased serum calcium levels.
- 3- **Anticoagulants :** heparin is the only acceptable one because EDTA, citrate and oxalate bind Ca^{2+} and reduce free Ca^{2+} .
- 4- **Change in posture :** standing leads to decrease intravascular water which leads to increase total Ca^{2+} , this explains mild hypocalcaemia in hospitalized patients.
- 5- **Excessive ingestion of milk** may cause increased levels.
- 6- **Serum pH** can effect calcium values . A decrease in pH causes increased calcium levels.
- 7-**Spectrophotometric interference by hemolyzed , icteric or lipemic** specimen should be avoided.

Clinical significance:

Hypercalcaemia (Increased level of calcium) are found in:

- 1- **Hyperparathyroidism , Non – parathyroid PTH- producing tumor (e.g., lung or renal carcinoma):** parathyroid or hormone mobilize calcium stores from the bone to the blood.
- 2- **Vitamin D intoxication :** Vitamin D works synergistically with PTH to increase serum calcium .
- 3- **Addison's disease:** Glucocorticosteroids inhibit vitamin D activity . When steroid activity is decreased , vitamin D action is enhanced . Vitamin D works synergistically with PTH to increase serum calcium .
- 4- **Metastatic tumor of bone . Paget disease of bone , prolonged immobilization :**
Bone destruction or thinning pushes calcium from the bone and into the blood.
- 5- **Acromegaly.**
- 6- **Hyperthyroidism.**

Hypocalcaemia (Decreased level of calcium) are found in:

- 1-**Hypoparathyroidism :** PTH acts to increase serum calcium .If PTH levels are reduced , serum calcium declines.
- 2- **Rickets , Vitamin D deficiency:** Vitamin D acts synergistically with PTH. PTH acts to increase serum calcium . Without that synergism , calcium levels decline.
- 3- **Osteomalacia , Malabsorption :** Less calcium available to the blood.
- 4- **Pancreatitis , Fat embolism :** Pancreatitis is associated with saponification (binding of calcium to fats) of the peripancreatic tissue (This reduces the calcium from the blood).
- 5- **Alkalosis :** High pH in the blood drives the calcium to intercellular spaces. Blood levels declines.