
بسم الله الرحمن الرحيم

CALCIUM AND PH IN THE HEMODIALYSIS PATIANT

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Introduction

- As kidney function declines, there is a progressive loss o the ability to maintain mineral homeostasis and normal bone turnover. Three hormones are involved primarily in maintaining mineral bone homeostasis in early CKD:

- FGF23
- calcitriol
- PTH

FGF23

- FGF23 (fibroblast growth factor 23) are increased.
- FGF23, produced by osteocytes,
- affects the function of renal tubular cells by acting on a Klotho-FGF receptor complex.
- FGF23 stimulates phosphaturia by decreasing the expression and activ- ity of sodium-phosphate cotransporters in the renal tubules.

Calcitriol

- Calcitriol is synthesized by the body in a 3-stage process.
- skin, converts 7-hydroxycholesterol into chole-calciferol (vitamin D3). Cholecalciferol is an inactive steroid prohormone;
- hydroxylated in the 25-position by the liver. This so-called "25-D"
- hydroxylation of the steroid ring at the 1-position. the most important site where 1,25-D is synthesized is in the renal tubules, by an enzyme called 1-a hydroxylase. Another name for 1,25-D is calcitriol.

Calcitriol

- increase gut calcium and phosphorus absorption
- increases cal- cium reabsorption in the kidney
- suppresses PTH
- helps mineralize bone.

Calcitriol

In early CKD, the levels of calcitriol are reduced. (1) increased levels of FGF23 suppress the 1-a hydroxylase enzyme in the renal tubules, blocking conversion of 25-D to 1,25-D, and

(2) reduced functioning renal mass.

compensatory, as slowing calcitriol synthesis results in reduced phosphorus absorption from the gut, and this in turn reduces the phosphorus excretion burden on the dwindling number of neph- rons. The reduced serum 1,25-D levels also result in reduction of gut calcium absorption, and higher serum phosphorus levels can result in lower serum calcium levels

PTH

- 84 amino acids, binding to its receptor; N-terminal
- main stimulus to PTH hypocalcemia, calcium-sensing receptors on the parathyroid gland.
- main functions of this hormone is to maintain the serum calcium level.
- (1) PTH decreases the reabsorption of ph in the kidney, increasing urinary ph excretion. This lowers serum ph, which tends to raise the serum calcium;
- (2) PTH stimulates the activity of the 1-a hydroxylase enzyme in the kidney that converts 25-D to 1,25-D; normally, this results in more calcitriol, and more calciu being absorbed via the gut;
- (3) increases bone turnover, up calcium from bone.

PTH

- PTH and FGF23 both act to increase renal phosphorus excretion, but they have the opposite effects on the kidney enzyme that makes 1,25D. In a feedback loop, secretion of PTH is inhibited by 1,25D acting on cal- citriol receptors in the parathyroid gland

stage 5 CKD and initiation of dialysis,

- high FGF23 and PTH levels,
- low calcitriol levels,
- hyperphosphatemia,
- low or low normal serum calcium

- Control of Hyperphosphatemia
- The normal range for serum phosphorus is 2.7 to 4.6 mg/dL (0.9–1.5 mmol/L).
- In dialysis patients, the KDIGO bone guidelines recommend attempting to maintain predialysis phosphorus in the normal range,

Dietary restriction.

- Restricting phosphorus in the diet to 800 to 1,200 mg per day is the key to controlling serum phosphorus.

Removal of phosphorus by dialysis

- • Hemodialysis typically removes about 800 mg of phosphorus per treatment regardless of predialysis seru levels.
- • For hemodialysis, the total weekly time on dialysis is the most important factor affecting phosphorus removal.
- • Peritoneal dialysis removes approximately 300 mg per day

- High flux dialyzers
- dialyzers with larger surface areas
- hemodiafiltration, can increase phosphorus clearance to a modest degre

- ***the total weekly time on dialysis is the most important factor affecting phosphorus removal.***

- After the first hour of dialysis, the intradialysis serum phos- phorus level tends to stabilize at a low level.
- The maintained intradialysis serum level of phosphorus cause it to behave somewhat like a middle molecule, wher even prolonged dialysis sessions con- tinue to improve phosphorus removal

- Dialysis frequency has an additional impact on phosphorus removal
- 24–28 hours per week of dialysis to allow a predialysis serum phosphorus level <4.5 m

Residual kidney function

- Patients with urine volumes >500 mL per day typically require

substantially lower amounts of phosphorus binders.

Phosphorus binders

- These agents work by binding phosphorus in the gastrointestinal tract, either by forming an insoluble complex or by binding it into a resin
- Recent observational data have suggested that the us of phosphorus binders may also correlate with longer survival and better nutritional status

Phosphorus binders (Continue…)

- Phosphorus binders in two broad categories:
- Those that contain calcium (calcium car-bonate and calcium acetate)
- Those that do not (sevelamer, lanthanum, magnesium carbonate, sucroferric oxyhydroxide, ferric citrate, and aluminum-containing compounds.

Calcium load associated with some phosphorus binders.

- Calcium acetate, on a gram-per-gram basis, is about as effective as calcium carbonate as a phosphorus binder.
- Calcium acetate contains only 25% calcium by weight
- Calcium carbonate contains 40% calciu by weight

- A. Calcium-containing:
- effective. low cost.
- KDIGO elemental not exceed 1.5 g per day.dialysis solution calcium concentration shoulc be limited to 2.25 to 2.5 mEq/L (1.12 to 1.25 mM)
- 1. Calcium Carbonate (40%) is available in a variety of preparations and dose sizes, includ- ing TUMS (200 mg regular tablet formulation),
- Caltrate (240 mg
- , and OsCal 500

- . A reasonable starting dose is 1–2 tablets with each meal.
- 1.5 g of elemental
- acidic environment:
- proton pump inhibitors.
- Common side effects include hyper- calcemia, constipation, and nausea.

- 2. Calcium acetate: 25% . 667 mg tablets (169 mg of elemental cal- cium)
- two tablets with each meal. titration every 2–3 weeks, maximum daily dose of 1.5 g of elemental .
- effi- cacy of the two drugs similar.
- side effects include hypercalcemia, nausea, and constipation,

- B. Sevelamer carbonate (Renvela)
- is a nonaluminum-, noncalcium- based phosphorus binder that traps phosphorus in the bowel through ion exchange and hydrogen binding.

- 400- and 800-mg tablets
- 800–1,600 mg three times per day with meals
- 13g per day
- 1 hour before or 3 hours after sevelamer administration.
- beneficial anti-inflammatory
- nausea, diarrhea, dyspepsia, and constipation.

- C. Lanthanum Carbonate (Fosrenol)
- noncalcium, nonaluminum-based binder.
- 250-, 500-, 750-, and 1,000-mg chew- able
- 500 mg three times
- exceed 1,250 mg three times per day
- main side effects are similar GI discom- fort
- chewable preparation

- D. Magnesium/calcium binders.
- Magnebind (magne- sium carbonate plus calcium carbonate),
- Osvaren (magnesium carbonate plus calcium acetate

- E. Sucroferric oxyhydroxide
- 500 Mg
- 1.5 gr daily
- MAX 3 gr daily

- .F. Ferric citrate
- iron-based phosphate binder that contain no calcium or aluminum.
- 210 mg ferric iron as 1 g ferric citrate and can be titrated to its maximum dose of 12 tablets/day (2.5 g ferric iron/day).
- (~50% less IV iron requirement (~24% less

- G. Aluminum carbonate and aluminum hydroxide.
- Aluminum-based binders were the primary therapy for hyperphosphatemia
- accumulation of aluminum to toxic levels was found to result in hematologic, neurologic, and bone.

- severely elevated phosphorus and calcium × phosphorus products in patient with severe hyperparathyroidism and/or concurrent hypercalcemia
- Co-ingestion of citrate (Shohl's solution, calcium citrate, fruit juices,

CALCIUM

The normal range for serum calcium is 8.4 to 10.2 mg/dL (2.10–2.55 mmol/L)

KDIGO

recommend maintaining predialysis total calcium within this range.

(the calcium level at which PTH secretion is 50% of maximum

Corrected calcium (in mg/dL) = total calcium + (0.8 × (4.0 − albumin [in g/dL]

Hypercalcemia

1-calcium-based binders

2- use of vitamin D receptor agonists that increase gut calcium absorption.

3- Patients with low PTH appear to have the highest range of serum calcium

Advanced hyperparathyroid- ism associated with a large mass of autonomous parathyroid tissue can rarely result in hypercalcemia in the absence of oral calcium administration or the use of active vitamin D. This is referred to as tertiary hyperparathyroidism

Hypocalcemia

- 1-poor gastrointestinal absorption of calcium due to vitamin D deficiency,
- 2-severe hyperphosphatemia,
- 3- use of the calcimimetic agent,
- 4- cinacalcet.


سپاس از حسن توجه شما