Renal Osteodystrophy

Renal osteodystrophy is defined by pathological bone features in a patient with chronic kidney disease/failure. It's a component of the spectrum of chronic kidney disease - mineral bone disorders (CKD-MBD). The diseased kidney results in a decreased ability to excrete phosphate. As phosphate builds up, it triggers growth factors to be released from the bone that inhibit calcitriol. Inhibited calcitriol leads to hypocalcemia and a compensatory parathyroid response, hence secondary hyperparathyroidism. Hyperphosphatemia and hypocalcemia are characteristic, as is decreased calcitriol. Clinical features include osteitis fibrosa cystica, osteoporosis, and osteomalacia. Management is aimed at treating the underlying kidney disease.

PLAY PICMONIC

Pathophysiology

Chronic Kidney Disease

Crone and Dead Kidney

Chronic kidney failure is characterized by the inability to excrete phosphate normally. Over time, this will result in a high phosphate level in the blood, which triggers the secretion of fibroblast growth factor (FGF) from the bone. FGF-23 can decrease calcitriol production and intestinal calcium absorption. Hypocalcemia then causes a compensatory PTH response.

Secondary Hyperparathyroidism

(2) Tutu Hiker-para-thigh-droid

Abnormalities found in renal osteodystrophy will trigger the parathyroid glands to secrete more parathyroid hormone to maintain homeostasis. This is also known as secondary hyperparathyroidism. If left untreated, secondary hyperparathyroidism can develop into tertiary hyperparathyroidism over many years. Tertiary hyperparathyroidism is a condition where hyperparathyroidism is refractory due to chronic renal disease. These will lead to high phosphate and calcium, resulting in deposits in the blood vessels and soft tissues.

Hyperphosphatemia

Hiker-phosphate-P

The inability of the kidney to excrete phosphate in renal failure causes hyperphosphatemia. This will initiate the onset of CKD-related mineral bone disorder.

Hypocalcemia

Hippo-calcified-cow

Hyperphosphatemia induces the release of fibroblast growth factor 23 from the bone. FGF-23 is an important mediator of phosphate homeostasis which helps increase the excretion of phosphate via urine in hyperphosphatemia. It also reduces the production and function of active vitamin D, Calcitriol, which decreases calcium absorption resulting in hypocalcemia.

Decreased Calcitriol

Down-arrow Calcified-troll

Chronic kidney failure also impairs the hydroxylation of vitamin D into calcitriol, which decreases intestinal calcium absorption. Patients with have decreased 1,25-dihydroxyvitamin D, or calcitriol.

Clinical Features

Osteitis Fibrosa Cystica

Ostrich-in-flames Fibrous-sacks Sisters

Osteitis fibrosa cystica can occur in up to 50% of renal osteodystrophy cases due to excess parathyroid hormone production. Increased osteoclast activity is the root of this process. It manifests as bone pain and is characterized by cystic bone spaces loaded with brown fibrous tissue. The brown color appears due to hemosiderin deposits from microhemorrhages. It can be present with subperiosteal bone resorption, which leads to cortical thinning.

Osteoporosis

Ostrich-with-porous-bones

Renal osteodystrophy can lead to osteoporosis. This will increase the risk of fracture in patients. Osteoporosis is characterized by bone loss and trabecular thinning with fewer interconnections.

Osteomalacia

Ostrich-Malaysia

Osteomalacia can be seen as a part of the spectrum of bone abnormalities in renal osteodystrophy. Osteomalacia is characterized by impaired bone mineralization, which can manifest as bone pain.

Management

Treating Underlying Disorder

Treating Disorders Under the Tent

Treatment of renal osteodystrophy is aimed at treating the underlying disorder. Dietary phosphate restriction is recommended in chronic kidney failure patients. Phosphate serum level should be below 5.5. mg/dL. A vegetarian diet helps restricts phosphate due to the low bioavailability of phosphate in vegetarian protein. If dietary phosphate restriction is not effective in reducing phosphate level, a phosphate binder may be indicated. Phosphate binders can be calcium-containing or non-calcium containing. Calcium-containing includes calcium carbonate and calcium acetate. Non-calcium containing agents include sevelamer and lanthanum. Vitamin D2 is recommended for patients with vitamin D below 30 ng/mL. Calcitriol is a potent vitamin D analog. Other options that can be considered are cinacalcet, sodium bicarbonate, bisphosphonates, and surgical parathyroidectomy.