CALCIUM METABOLISM IN CHRONIC RENAL FAILURE

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There has been a large body of accumulating information that the survival of patients with chronic renal failure can be prolonged considerably by peritoneal dialysis. However, on the other hand, new complication have arisen and are becoming some clinical problem in these patients with artificially prolonged survival. Main complications are all related to calcium metabolism, namely, pseudogout, metastatic calcification and so-called azotemic renal osteodystrophy. We have carried out a study on calcium metabolism in chronic renal failure with particular emphasis on the following aspects:

1) the absorption and excretion of calcium, 2) plasma levels of vitamin D and parathyroid hormone (PTH), and 3) mechanism of azotemic renal osteodystrophy and metastatic calcification. The study was carried out in 84 uremic patients including 58 males and 26 females. Their age ranged from 18 to 75 with a mean age of 33.5. A duration of azotemia in these patients was 10.7 months in average.

(1) Intestinal absorption of Ca$^{47}$ in these patients with chronic renal failure was markedly reduced. Oral administration of vitamin D with a daily dose of 100,000 units improved only slightly. (Fig.1)

(2) The plasma level of vitamin D in these patients was found within normal limits ranging 85 to 140 units per 100 ml.

(3) The plasma level of PTH was measured in 9 patients using radioimmunoassay technique. All the patients demonstrated a marked increase in the plasma concentration of PTH even higher than that found in a case of primary hyperparathy-
Fig. 1 Comparison of Plasma Levels of $^{47}\text{Ca}$ in Percent Dose Per Liter After Oral Administration to Normals and Uremic Patients

Fig. 2 Plasma Concentration of PTH in Patients with Chronic Renal Failure
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In one patient, the determination was repeated after peritoneal dialysis had been performed, and the value found to be reduced. (Fig. 2)

(4) Bone survey performed in 39 patients revealed pathological fracture in one case, disappearance of lamina dura in 7 patients, diminished bone density in 26 patients and increase bone density in 3 patients. Mineral content in ulna of these patients was measured using radiographic method. The results were summarized in Figure 3. It is obvious from Figure 3 that the mineral content in ulna of uremic patients was significantly reduced. Bone density of ulna was slowly but progressively reduced in the majority of uremic patients treated with dialysis. The reduction of bone density was found enhanced in the bedridden patients. On the contrary, the patients receiving hemodialysis on the outpatient basis and having made a complete social rehabilitation showed no or minimal reduction in bone density of ulna. In one

Fig. 3 Mineral Contents in Ulna of Uremic Patients

- ch. renal failure 45
- control 100
patient, a sudden and progressive reduction in bone density was found just prior to the appearance of metastatic calcification.

(5) Metastatic calcifications found on X-ray were as follows; calcifications in periarticular soft tissue in 5 patients, calcified vessels in 8 cases and new bone formation in 7 patients among 39 patients studied.

(6) Among 21 patients studied of parathyroid glands, hyperplasia was found in 17 cases on post-mortem examination. The patients who had suffered a prolonged chronic renal failure showed a tendency to demonstrate hyperplasia of mainly chief cell in type. Microscopic calcification of renal cortex was found in the majority of patients autopsied.

Pathogenesis of azotemic renal osteodystrophy has not been clarified as yet. However, our data indicate that multiple factors, such as vitamin D resistance, increased circulating PTH, metabolic acidosis and hyperfunction of the parathyroid glands are probably all responsible for the abnormal calcium metabolism in chronic renal failure.