Aluminum Deposition in Bone Due to Aluminum Hydroxide Consumption

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Dear Sir,

Aluminum intoxication has been suggested as the cause of the dialysis dementia syndrome and a form of vitamin D resistant osteomalacia among patients undergoing regular dialysis therapy [1]. The source of the aluminum has been considered to be contamination of the dialysis bath, but there have been case reports of dialysis dementia related to aluminum gel ingestion [2, 3]. We report here a case of aluminum-related osteomalacia where the source of intoxication would seem to be aluminum hydroxide ingestion.

Case Report

A 25-year-old painter was admitted because of edema, abdominal pain, and oliguria. Renal biopsy showed severe extracapillary glomerulonephritis with 100% of glomeruli affected by crescents. Immunofluorescence microscopy revealed anti-GBM disease. The patient was treated by dialysis, plasmapheresis, steroids and azathioprine, but remained almost totally anuric. An arteriovenous fistula was created and the patient entered the chronic renal dialysis programme. He was dialyzed for 4 h 3 times weekly using a Gambro AK5 monitor and a Gambro 1.36 m² (later 1.8 m²) artificial kidney. The dialysis bath was purified by reverse osmosis and the aluminum concentration in the water, measured by atomic absorptiometry [4] was 0 (range 0–0.3 µmol/l). The calcium concentration was 3.6–3.8 mEq/l. He was treated for hyperphosphatemia using aluminum hydroxide in doses up to 3 g daily, in all 2.9 k. After 1 year the patient developed hypercalcemia (serum calcium 2.71–3.2, reference interval 2.17–2.65) but the alkaline phosphatase activity remained normal. The parathyroid hormone (PTH) using a C-terminal assay was 2.2 µg/l (reference interval 0.22–0.5), about average for the dialysis center.

After 4 years the patient developed neurological symptoms with faints, periods of amnesia, depression and grand mal attacks. After a fall he complained of back pain and X-ray revealed vertebral compression fractures of T 3, 5, 7. Review of bone mineral content determinations during the period of dialysis revealed a fall from 59.7 to 55.7 units (reference interval 50–88), a fall of 4.0 units as opposed to expected 1.0.

Investigation revealed the following (reference intervals in brackets): serum calcium 2.77 (2.17–2.65); serum phosphate 1.6 (0.8–1.5); alkaline phosphatase activity 192 (80–275) units; PTH 695 pmol/l (30–130); serum aluminum 2.8 mmol/l (less than 0.6). CT scanning revealed cortical atrophy.

Fig. 1. Bone biopsy showing aluminium deposition along the mineralization (front).

Fig. 2. Bone biopsy showing increased osteoid (surface).

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After tetracycline intravital double-labelling a bone biopsy was taken from the right iliac crest. Histological examination revealed the following. The cortex was thin but contained normal osteons with normal remodelling activity. A normal amount of spongiosa was found, consisting of trabeculae of varying width, often anastomosing with each other. The bone had a normal lamellar structure. The surface showed marginally increased resorptive activity and only occasional osteoclasts were seen. However, the extent of surface osteoid was increased, although osteoid width was normal. Only flattened, probably inactive, osteoblasts were seen. Fluorescent microscopy revealed no deposition of tetracycline, suggesting severe mineralization defect. Some of the mineralization fronts showed narrow bands of aluminum deposition after staining for aluminum.

Conclusion: bone biopsy with aluminum deposition, increased osteoid surface and mineralization defect.

Comment

It is unlikely that the source of aluminum found on bone biopsy stems from the dialysis bath, as we have been unable to demonstrate measurable amounts of aluminum in the water. This is not surprising, as reverse osmosis is a very effective purifying procedure. We have previously demonstrated that patients in our center have considerably raised serum aluminum concentrations, and that the serum aluminum correlates closely with both the cumulative consumption of aluminum hydroxide and the present dose [5]. It is therefore likely that the source of aluminum in this patient is aluminum hydroxide consumption. The clinical, biochemical and histological picture is compatible with previous descriptions of aluminum-related osteomalacia. The patient's neurological symptoms are nonspecific. Dementia due to previous exposure to organic solvents, and dialysis dementia are two possible diagnoses that have been considered. The administration of aluminum hydroxide has been stopped and the outcome will be awaited.

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