

THE IN VIVO BINDING SERUM PHOSPHATE WITH TC-99M PERTECHNETATE IN A PATIENT WITH RENAL OSTEODYSTROPHY

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ABSTRACT

Secondary hyperparathyroidism and renal osteodystrophy are major complications of end stage renal failure, resulting from disorders in the regulation of parathormone, calcium, phosphorus, and vitamin D. We present a 16-year old woman as a case of renal osteodystrophy who referred to our hospital because of strong bone pains, growth retardation and walking disability. As a result of resistance to drug treatment in this patient, the radioguided parathyroidectomy was planned; consequently parathyroid and thyroid scintigraphy were done. In thyroid scan with Tc-99m sodium pertechnetate, there was an increased radioactivity uptake in middle line on thoracic region that

was thought to be sternum. Then neck scan, images of the thorax, abdomen and pelvic region were obtained. The radiopharmaceutical uptake in those images was seen in the vertebrae, pelvis, and sternum. Alongside, there was a normal distribution of Tc-99m pertechnetate at salivary gland and stomach in images. These data provided that Tc-99m sodium pertechnetate binded with in vivo phosphate because of high bone turnover in this patient who had hyperphosphatemia.

Key Words: In-vivo labeling, Tc-99m sodium pertechnetate, secondary hyperparathyroidism, renal osteodystrophy, end stage renal failure *Nobel Med 2012; 8(1): 107-109*

BİR RENAL OSTEODİSTROFİ HASTASINDA SERUM FOSFATININ TC-99M PERTEKNETAT İLE İN VİVO BAĞLANMASI

ÖZET

İkincil hiperparatiroidi ve renal osteodistrofi, parathormon, kalsiyum, fosfor ve vitamin D'nin regülasyonundaki bozuklukla sonuçlanan son dönem böbrek yetersizliğinin major komplikasyonlarıdır. Bu yazımızda kemiklerinde şiddetli ağrı, büyüme geriliği ve yürüyememe şikayetleri ile hastanemize başvuran 16 yaşında bir kadın hastayı sunuyoruz. Takibinde ilaç tedavisine direnç gelişmesi sonucunda, hastaya gama prop klavuzluğunda (radioguided) paratiroidektomi yapılması planlandı, bu nedenle paratiroid ve tiroid

sintigrafisi yapıldı. Tc-99m perteknetatla yapılan tiroid sintigrafisinde toraks bölgesinde orta hatta sternuma ait olduğu düşünülen artmış aktivite tutulum gözlemlendi. Boyun bölgesinin görüntülenmesinden sonra, torakstan, abdomenden ve pelvisten görüntüler elde edildi. Bu imajlarda radyofarmasötik tutulumu vertebrada, pelviste ve sternumda görüldü. Yanısıra tükrük bezi ve midede Tc-99m perteknetat normal dağılıyordu. Bu bulgular yüksek kemik döngüsünden dolayı hiperfosfatemisi olan hastada, fosfatla Tc-99m perteknetatın in vivo bağlandığını düşündürdü.

Anahtar Kelimeler: İn vivo bağlanma, Tc-99m sodium perteknetat, ikincil hiperparatiroidi, renal osteodistrofi, son dönem böbrek yetmezliği *Nobel Med 2012; 8(1): 107-109*

INTRODUCTION

Renal osteodystrophy is a spectrum of bone disorders that develop in patients with end stage renal failure (ESRF). The bone abnormalities in this situation are osteitis fibrosa (high turnover bone), mixed lesion, osteomalacia, adynamic bone (low turnover bone), aluminum bone disease, amyloid bone disease and metastatic calcification. High turnover bone disease caused by excess parathormone (PTH) release is the main characteristic of renal osteodystrophy. The stimuli for PTH secretion in uremia is based on phosphate retention, hypocalcemia, decreased production of calcitriol, resistance to calcitriol, abnormal sensitivity to calcium, direct effects of phosphate and skeletal resistance to PTH.

Clinical manifestations of renal osteodystrophy are associated with bones (pain, deformities, and fractures) or metastatic calcifications. Radiographic methods are of little use in the characterization of the type of osteodystrophy, but they may be of help in assessing mineral loss from the skeleton. Bone biopsy is the definitive means of diagnosis. The biochemical markers are plasma phosphate, calcium, alkaline phosphatase, bicarbonate and intact parathyroid hormone. The management of renal osteodystrophy should address all the pathogenetical mechanisms. Correction of the abnormalities in calcium and phosphate metabolism and prevention of aluminum osteodystrophy are the cardinal rules of management.¹ We report a case of renal osteodystrophy who has hyperphosphatemia and high turnover bone, in the scan of whom we thought phosphate binded with Tc-99m pertechnetate in vivo.

CASE REPORT

A 16-year old woman was referred to our hospital with complaints of strong bone pains, growth retardation and walking disability. She had been diagnosed with secondary hyperparathyroidism and renal osteodystrophy 2 years ago and was continuing on peritoneal dialysis programme. Serum calcium level was normal (9 mg/dl) as a result of having calcium replacement. Serum PTH, inorganic phosphate and alkaline phosphatase levels were measured higher than normal values as 2500 pg/ml, 6.67 mg/dl, 2628 U/L, respectively.

Because of the patient had drastic symptoms and resistance to drug treatments, the radioguided parathyroidectomy was planned. In preparation, parathyroid imaging with Tc-99m sestamibi and thyroid imaging were done in different days. Thyroid imaging was obtained 15 minutes after i.v. Tc-99m pertechnetate, which directly maintained from generator, using a dual-head gamma camera (Siemens; E-Cam; Germany) equipped with a pinhole collimator. Scintigraphic data were acquired 256x256 matrix size and the energy peak was centered

at 140 keV with a 20% window. Imaging time for display was 10 minutes. The increased activity in thyroid scintigraphy was observed on superior mediastinum along normal distribution of Tc-99m pertechnetate at thyroid and salivary gland. So as to explain unexpected activity at mediastinum, imaging was performed 25 minute after radiopharmaceutical administration from thoracic region with low energy all purpose collimator. This unexpected uptake of sternal region was thought to be sternum. In addition, there were uptakes in both proximal humeral regions and shoulder joints on this frame (Figure 1A). Additional images were obtained from thoracoabdominal region at anterior and posterior positions. In Figure 1B, both humerus, radius, ulna, iliac bones, elbow joints and coxofemoral joints were keep the radioactivity, as well as the Tc-99m pertechnetate uptake at stomach were seen as its normal distribution. The activity uptake at vertebral column, iliac bones and both proximal femur were observed in posterior image (Figure 1C) as like bone scintigraphy.

DISCUSSION

Secondary hyperparathyroidism, is a direct result of decreased renal function, vitamin D deficiency, and impaired mineral metabolism, aggravated in most patients during the progression of ESRF and is associated with renal osteodystrophy, extraskeletal calcification, and cardiovascular disease, resulting in increased mortality. The elevated PTH levels stimulate calcium mobilization from bone and regulate directly osteoblast apoptosis to correct hypocalcaemia. A further consequence of secondary hyperparathyroidism arises from the growth of the nodular tissue that accompanies parathyroid gland hyperplasia. In addition to elevated PTH levels, hyperphosphatemia accelerates parathyroid cell proliferation, which can result in nodular hyperplasia and severe hyperparathyroid bone disease.² This nodular tissue has been shown to be less sensitive to elevated calcium levels, severing the calcium-level feedback loop.³ In children with ESRF hyperphosphatemia is observed at glomerular filtration rate (GFR) levels below 40 ml/min/1.73 m² and almost always in children on dialysis. The increased plasma phosphate levels have a profound effect on soft tissue and vascular calcification, which are often observed in young patients on or even after dialysis, as well.^{4,5} In case of severe and therapy-refractory hyperparathyroidism with radiological signs in combination with hypercalcemia and/or elevated hyperphosphatemia, parathyroidectomy has to be considered. Similarly, therapy-refractory hyperparathyroidism, hyperphosphatemia, parathyroid gland hyperplasia in parathyroid imaging with sestamibi, performed as a part of parathyroidectomy plan, were also seen in our patient.

In addition to measurement of PTH, the levels of several enzymes and matrix proteins synthesized from osteoblasts →

and protein fragments released after bone matrix breakdown have been proposed in recent years as serum biochemical markers of bone formation and resorption rates. Serum bone-specific alkaline phosphatase appears to be essential for the process of mineralization and bone formation; it provides useful information regarding the rate of bone turnover in hemodialysis patients. The biochemical and radiological abnormalities are not reliable means of predicting the presence of osteomalacia, but a raised serum alkaline phosphatase is a good indicator of the presence of osteitis fibrosa. Our patient had high alkaline phosphatase level but we did not measure bone isoenzyme of this biochemical marker. It was supposed that increase of total alkaline phosphatase level was derived from bone isoenzyme, because the patient did not have any hepatic or intestinal disorder. Nonetheless, total alkaline phosphatase is also used to estimate bone formation but bone specific isoenzyme is sensitive to determination of renal osteodystrophy than total alkaline phosphatase.⁶ She had also strong bone pain, which is usually a symptom of developing osteomalacia but not of hyperparathyroidism or osteoporosis, and growth retardation.

Although we did not inject bone-seeking radiopharmaceutical to this patient, bone uptake was interestingly seen with Tc-99m pertechnetate. The bone seeking radiopharmaceuticals derived from phosphate are classified as two-phosphate version of phosphate (pyrophosphate), diphosponate (two phosphate linked by a carbon atom) and three phosphatase (etidronate, methylene phosphanate, hydroxymethylene diphosphanate).⁷ In bone scintigraphy, this derived phosphate was binded with Tc-99m pertechnetate in vitro. The increased phosphate level and high bone turnover in this patient might cause probably to bind of Tc-99m pertechnetate with phosphate in vivo. Consequently, we had seen unexpected activity uptakes

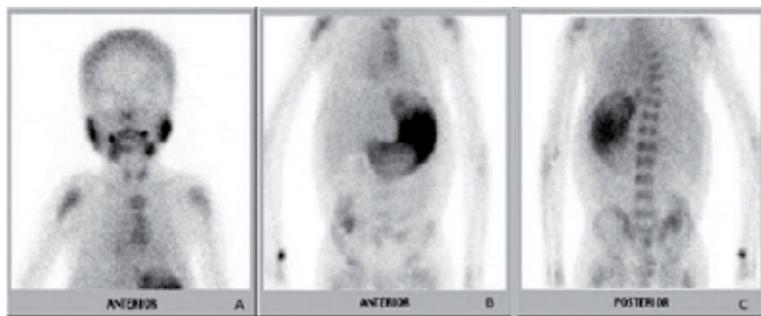


Figure 1. In vivo binding of serum phosphate with Tc-99m sodium pertechnetate in a patient with secondary hyperparathyroidism. (A) Anterior image of head, neck and thoracic region, (B) anterior image and (C) posterior images of thoracoabdominal region.

at bones and joints during thyroid scan (Figure 1). Bone scintigraphy has been acknowledged as a sensitive method for early detection and assessment of metabolic bone disease. The skeletal uptake index of bone-seeking radiopharmaceuticals, expressed as the bone-to-soft-tissue ratios (B/ST ratios) of tracer, has been proposed as a noninvasive and effective method for measurement of bone turnover.⁸ Abnormal bone scintigraphy reflects abnormally increased bone turnover.⁹ Bones showing an increased uptake of radiopharmaceuticals include the skull, mandible, sternum, shoulders, vertebrae and distal thirds of the long bones. Plotast et al. found that bone scan changes progress significantly with prolongation of dialysis treatment, especially in patients of younger age with higher PTH levels.¹⁰

As a conclusion, this unexpected bone uptake on thyroid scintigraphy in our patient provided that Tc-99m pertechnetate may be reduced and binded partially with in vivo phosphate, because normal distribution of newly obtained Tc-99m pertechnetate from generator can be seen in salivary gland and stomach.



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