

MARY LEONARD, MD

PHILADELPHIA, PENNSYLVANIA, USA

IMAGING TECHNIQUES FOR THE ASSESSMENT OF RENAL OSTEODYSTROPHY

Mary Leonard, MD
Philadelphia, PA, USA

The majority of studies of bone health in CKD relied on dual energy x-ray absorptiometry (DXA) measures of bone mineral density (BMD). However, DXA summarizes the total bone mass within the projected bone area (areal-BMD), concealing disease effects on trabecular and cortical bone. For example, in high-turnover ROD, increased trabecular volume may offset cortical bone loss, resulting in normal or increased BMD despite poor bone strength.(1) Fracture risk correlates poorly with DXA BMD in CKD. CKD patients with vertebral or fragility fractures have spine BMD that is comparable to those without fractures.(2, 3) Cortical bone loss in CKD likely results in significant decrements in bone strength. DXA BMD at the cortical radius was significantly lower in vertebral fracture compared with non-fracture patients, while lumbar spine BMD did not differ.(2) Finally, degenerative changes and vascular calcification inflate spine DXA measures of BMD. Our preliminary DXA data in over 200 adults with CKD stage 3 – 4 demonstrate significantly increased hip and spine areal-BMD for age, compared with controls.

Quantitative computed tomography (QCT) enables discrete assessment of cortical and trabecular volumetric BMD and dimensions. QCT measures of cortical dimensions predict fracture load in the radius and femoral neck in the absence of renal disease.(4) Spine QCT results in patients with CKD confirm biopsy data: trabecular BMD was increased in high-turnover disease (+ 1.6 SD) and decreased in low-turnover disease (-1.2 SD), relative to age-matched controls.(5) Tibia QCT data illustrate the opposing effects of CKD on trabecular and cortical bone: trabecular BMD was increased (+ 0.50 SD) and cortical BMD was decreased (-2.19 SD).(6) Our preliminary QCT data in over 200 adults with CKD stage 3 – 4 demonstrate significantly decreased cortical density and thickness in the tibia midshaft.

QCT is an incomplete solution in the setting of CKD because QCT does not assess trabecular micro-architecture. Increased or normal trabecular volumetric BMD on QCT may represent osteitis fibrosa and altered micro-architecture with impaired strength. Micro-magnetic resonance imaging (μ MRI) provides a non-invasive technique to assess trabecular architecture. The μ MRI data are quantified by 3D digital processing methods to determine trabecular properties. Our pilot study of μ MRI in dialysis patients revealed significant reductions in cortical thickness and suggested deterioration in the trabecular network.(7) Future studies are needed to compare the sensitivity and specificity of DXA, QCT and MRI in the detection of skeletal fragility in CKD.

1. Parfitt AM. A structural approach to renal bone disease. *J Bone Miner Res* 1998;13(8):1213-20.
2. Yamaguchi T, et al. Retrospective study on the usefulness of radius and lumbar bone density in the separation of hemodialysis patients with fractures from those without fractures. *Bone* 1996;19:549-55.
3. Jamal SA, et al. Bone density and heel ultrasound testing do not identify patients with dialysis-dependent renal failure who have had fractures. *Am J Kidney Dis* 2002;39:843-9.
4. Augat P, et al. Prediction of fracture load at different skeletal sites by geometric properties of the cortical shell. *J Bone Miner Res* 1996;11:1356-63.
5. Torres A, et al. Comparison of histomorphometry and computerized tomography of the spine in quantitating trabecular bone in renal osteodystrophy. *Nephron* 1986;44:282-7.
6. Tsurusaki K, et al. Differential effects of menopause and metabolic disease on trabecular and cortical bone assessed by peripheral quantitative computed tomography. *Br J Radiol* 2000;73:14-22.
7. Wehrli FW, et al. Quantitative high-resolution magnetic resonance imaging reveals structural implications of renal osteodystrophy on trabecular and cortical bone. *J Magn Reson Imaging* 2004;20(1):83-9.