Ovariectomy and dietary induced metabolic acidosis both result in decreased bone quality through different mechanisms: Experience with an ovine model.

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Rapid production of osteopenia (OP) in an animal model with bone quality that resembles human OP has been elusive to researchers. Furthermore dietary induced metabolic acidosis (DIMA) has been implicated in the development of human OP. Use of DIMA in sheep may fulfill two objectives 1) provide a rapid method to induce OP that resembles the human condition and, 2) support the hypothesis that DIMA plays a role in the development of OP in humans. We have studied a group of sheep that consumed an acidotic diet for 6 months. Four groups of 6 sheep comprised normal diet (ND), acidotic diet (MA), ND + ovariectomy (OVX) and MA + OVX. Another group of sheep with OVX and MA was evaluated at 12 months.

Treatment, especially DIMA, induced a lower blood pH, increased urinary fractional excretion of Ca and P, increased serum bone alkaline phosphatase and osteocalcin, decreased PTH, and decreased vertebral bone density as measured by dual-energy X-ray absorptiometry (DEXA). With DIMA, vertebral static and dynamic histomorphometry revealed increased bone formation rate, increased mineralizing surface and bone surface of the lumbar vertebrae and decreased percent bone and increased star volume in paired iliac crest biopsies taken at 0 and at 6 mos. There was no histologic evidence of osteomalacia. In contrast, OVX decreased bone turnover resulting in decreased percent bone and increased star volume. Mechanical testing demonstrated increased cancellous fragility and FTIR decreased mineralization. Both were more exaggerated in DIMA than with OVX. Analysis of the radii suggested that the increase in compact bone remodeling associated with either OVX or DIMA represented a process limited to secondary osteons rather than a global increase in remodeling. Mechanical testing supported an increase in viscoelasticity with anisotropy and was different between OVX and DIMA. Analysis of the femur revealed cortical thinning, increased diaphyseal perimeter, decreased BMD of the entire bone but increased BMD of cortical bone.

These results indicate that in the sheep model, DIMA induces a rapid change in cortical and trabecular bone resulting in decreased bone quality that is similar to human patients with high turnover OP. Changes in bone quality secondary to OVX are slower to occur and likely occur secondary to decreased rather than increased bone turnover.