Effects of long-term alendronate treatment on bone mineralisation, resorption parameters and biomechanics of single human vertebral trabeculae.

Abstract:
Due to their well-established fracture risk reduction, bisphosphonates are the most frequently used therapeutic agent to treat osteoporosis. Bisphosphonates reduce fracture risk by suppressing bone resorption, but the lower bone turnover could have a negative impact on bone quality at the tissue level. Here, we directly assess the structural and mechanical characteristics of cancellous bone from the lumbar vertebrae (L5) in non-treated osteoporotic controls (n=21), mid-term alendronate-treated osteoporotic patients (n=6), and long-term alendronate-treated osteoporotic patients (n=7). The strength and toughness of single trabeculae were evaluated, while the structure was characterised through measurements of microdamage accumulation, mineralisation distribution, and histological indices. The alendronate-treated cases had a reduced eroded surface (ES/BS, p<0.001) and a higher bone mineralisation in comparison to non-treated controls (p=0.037), which is indicative of low turnover associated with treatment. However, the amount of microdamage and the mechanical properties were similar among the control and treatment groups. As the tissue mineral density (TMD) increased significantly with alendronate treatment compared to
non-treated osteoporotic controls, the reduction in resorption cavities could counterbalance the higher TMD allowing the alendronate-treated bone to maintain its mechanical properties and resist microdamage accumulation. A multivariate analysis of the possible predictors supports the theory that multiple factors (e.g., body mass index, TMD, and ES/BS) can impact the mechanical properties. Our results suggest that long-term alendronate treatment shows no adverse impact on mechanical cancellous bone characteristics.