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Changes with age in the trabecular bone structural units (BSU) of the lumbar spine

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ABSTRACT:
Age-related fractures are common at skeletal sites with high proportions of cancellous bone such as the hip and spine. Because the populations in industrialized countries are ageing, the incidence of such fractures are expected to increase. Previous research has shown that measures of bone quantity (e.g. bone mineral density) are imperfect predictors of fracture risk, so recent efforts have focused on combining them with measures of bone architecture. The trabeculae themselves are composed of individual bone structural units (BSU) bonded together by cement lines. The size and arrangement of these BSU can be expected to contribute to the mechanical and failure behavior of cancellous bone; however, to date these features have received little attention.

The goal of the present research is to examine morphometric changes with age in the trabecular BSU of vertebral cancellous bone. Half of the L2 vertebrae from 8 young (aged 18-38) and 8 old (aged 69-96) females, with no history of fracture, were embedded in plastic. Thin frontal sections from the centre of each vertebral specimen were prepared and immunostained for osteopontin to highlight the cement lines of the BSU. The contour of each BSU was manually traced using ImageJ on high resolution scans of the sections. Polarized light microscopy was used to clarify any ambiguous staining. A number of parameters were recorded including the BSU perimeter, area, length, thickness, its shape descriptors, and the length of cement line per unit area. The older vertebrae had significantly smaller BSUs, and accordingly, had more BSUs per unit area and more cement line per unit area than the younger vertebrae. Given the high mineralization and brittleness of the cement line, its increased proportion with age likely contributes to increased fracture risk.