Molecular Mechanics of Bone Fracture

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Bone fracture and the fear of bone fracture are significant problems that affect the quality of life of many elderly people. Despite centuries of research on bone since Galileo's work on it, fundamental questions of why and how bone fractures remain unanswered. Fractures originate in the highly intricate and heterogeneous molecular structure of bone, which has now been imaged with unprecedented resolution with the Atomic Force Microscope and with new Scanning Electron Microscopes on campus. New high speed photography shows bone fracture processes in real time. The resultant fracture cracks, when imaged with 3D Scanning Electron Microscopy, reveal filaments of molecular "glue" that are resisting the opening of the cracks. Immunohistochemistry reveals that this glue contains phosphorylated, non-collagenous proteins. Molecular mechanics, measured with the Atomic Force Microscope, gives new insights into how this glue dissipates the energy from impacts that would otherwise completely fracture the bone. In summary, our novel, but increasingly accepted, hypothesis is that the non-collagenous proteins in bone act as a glue to prevent bone fracture. Part of the increased fracture risk for elderly people may be due to degeneration of this glue.