Collagen can withstand more strain than previously known

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Researchers in the Department of Physics at King's College London have discovered that collagen fibrils can withstand a significantly higher amount of strain than previously thought, broadening our understanding of tissue mechanics.

Collagen fibrils are microscopic "ropes" that hold human and animal tissue together, without which tissues such as skin and tendon would fall apart, and bone would become extremely brittle. Until now, collagen fibrils had been perceived as almost inextensible, acting more like steel cables than bungee ropes.

Using a new method in which fibrils are deposited on a flexible foil and then probed by Atomic Force Microscopy, Ph.D. student Emilie Gachon found that collagen fibrils could easily be pulled by up to 25% without breaking or, indeed, showing any sign of damage. She also observed that fibrils become stiffer when first pulled, but then softer again when pulled further. This peculiar mechanical behavior could be explained by the internal structure of the fibrils, which is similar to those found in rubber-like materials.

Dr. Patrick Mesquida, principal investigator, commented: "Understanding what governs mechanical behavior is important because we know that it is likely to change during disease or aging. As tissue cells depend on collagen to work a certain way, any mechanical changes may further damage the cells, leading to malfunctions such as poor wound-healing and increased spread of cancer. Consequently, further research will focus on what happens when the fibrils are strained and released many times, which is closer to what naturally happens in human or animal tissue."

On the impact of this research on future developments in the field, Emilie further commented: "Collagen is being increasingly used by tissue engineers as a scaffold for cells in the hopes of one day being able to grow tissue outside the human body. The properties uncovered in our work could help engineers fine-tune the properties of these scaffolds to promote specific cellular behavior. Furthermore, we know that collagen fibrils are highly crosslinked in some diseases such as diabetes. Our data shows that abnormal levels of crosslinking results in different mechanical behavior of collagen fibrils. Tracking collagen fibril mechanics to detect abnormal crosslinking amounts could be a way of detecting early stage diabetes."

More information: Emilie Gachon et al. Stretching Single Collagen Fibrils Reveals Nonlinear Mechanical Behavior, *Biophysical Journal* (2020). DOI: 10.1016/j.bpj.2020.01.038

Provided by King's College London

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