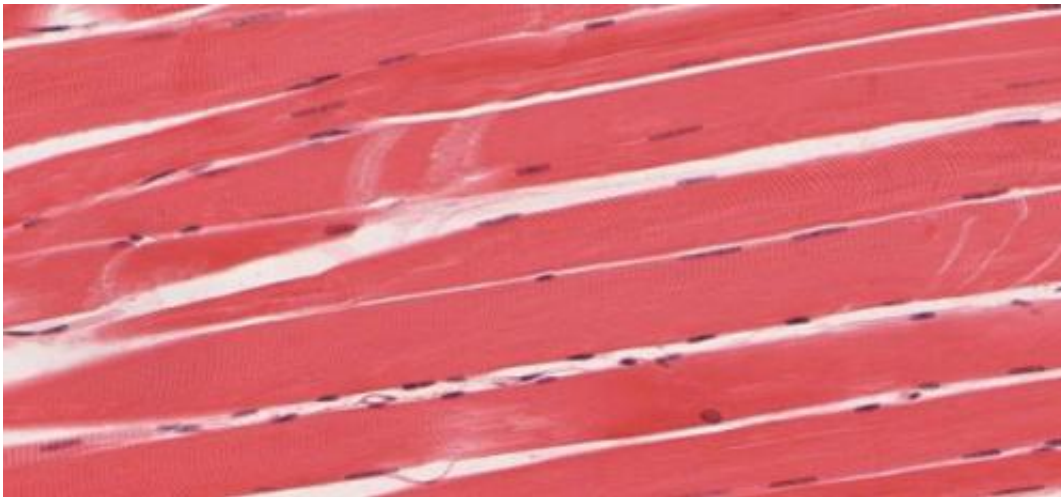# Researchers use 3-D imaging to improve diagnosis of muscle diseases

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Skeletal muscle tissue. Credit: University of Michigan Medical School

Biotechnologists at Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) have developed a system to accurately measure muscle weakness caused by structural changes in muscle tissue. The new method allows muscle function to be assessed using imaging without the need for sophisticated biomechanical recordings, and could in future even make taking tissue samples for diagnosing myopathy superfluous. The results have been published in the renowned journal *Light: Science & Applications*.

The muscle is a highly ordered and hierarchically structured organ. This

is reflected not only in the parallel bundling of muscle fibres, but also in the structure of individual cells. The myofibrils responsible for contraction consist of hundreds of identically structured units connected one after another. This orderly structure determines the force which is exerted and the strength of the muscle. Inflammatory or [degenerative diseases](#) or cancer can lead to a chronic restructuring of this architecture, causing scarring, stiffening or branching of muscle fibres and resulting in a dramatic reduction in muscular function. Although such changes in muscular morphology can already be tracked using non-invasive multiphoton microscopy, it has not yet been possible to assess [muscle strength](#) accurately on the basis of imaging alone.

New system correlates structure and strength

Researchers from the Chair of Medical Biotechnology have now developed a system that allows muscular weakness caused by structural changes to be measured at the same time as optically assessing muscular architecture. "We engineered a miniaturized biomechatronics system and integrated it into a multiphoton microscope, allowing us to directly assess the strength and elasticity of individual muscle fibres at the same time as recording structural anomalies," explains Prof. Dr. Oliver Friedrich. In order to prove the muscle's ability to contract, the researchers dipped the muscle cells into solutions with increasing concentrations of free calcium ions. Calcium is also responsible for triggering muscle contractions in humans and animals. The viscoelasticity of the fibres was also measured, by stretching them little by little. A highly-sensitive detector recorded mechanical resistance exercised by the muscle fibres clamped on the device.

Data pool for simplified diagnosis

The technology developed by researchers at FAU is, however, merely

the first step towards being able to diagnose muscle disorders much more easily in future: "Being able to measure isometric strength and passive viscoelasticity at the same time as visually showing the morphometry of muscle cells has enabled us, for the first time, to obtain direct structure-function data pairs," Oliver Friedrich says. "This allows us to establish significant linear correlations between the structure and function of muscles at the single fibre level."

The data pool will be used in future to reliably predict forces and biomechanical performances in skeletal muscle exclusively using optical assessments based on SHG images (the initials stand for Second Harmonic Generation and refer to images created using lasers at second harmonic frequency), without the need for complex strength measurements. At present, muscle cells still have to be removed from the body before they can be examined using a multiphoton microscope. However, it is plausible that this may become superfluous in future if the necessary technology can continue to be miniaturized, making it possible for muscle function to be examined, for example, using a micro-endoscope.

More information: Dominik Schneidereit et al, Optical prediction of single muscle fiber force production using a combined biomechatronics and second harmonic generation imaging approach, *Light: Science & Applications* (2018). DOI: 10.1038/s41377-018-0080-3

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