An innovative approach for evaluating muscle coordination and fatigue

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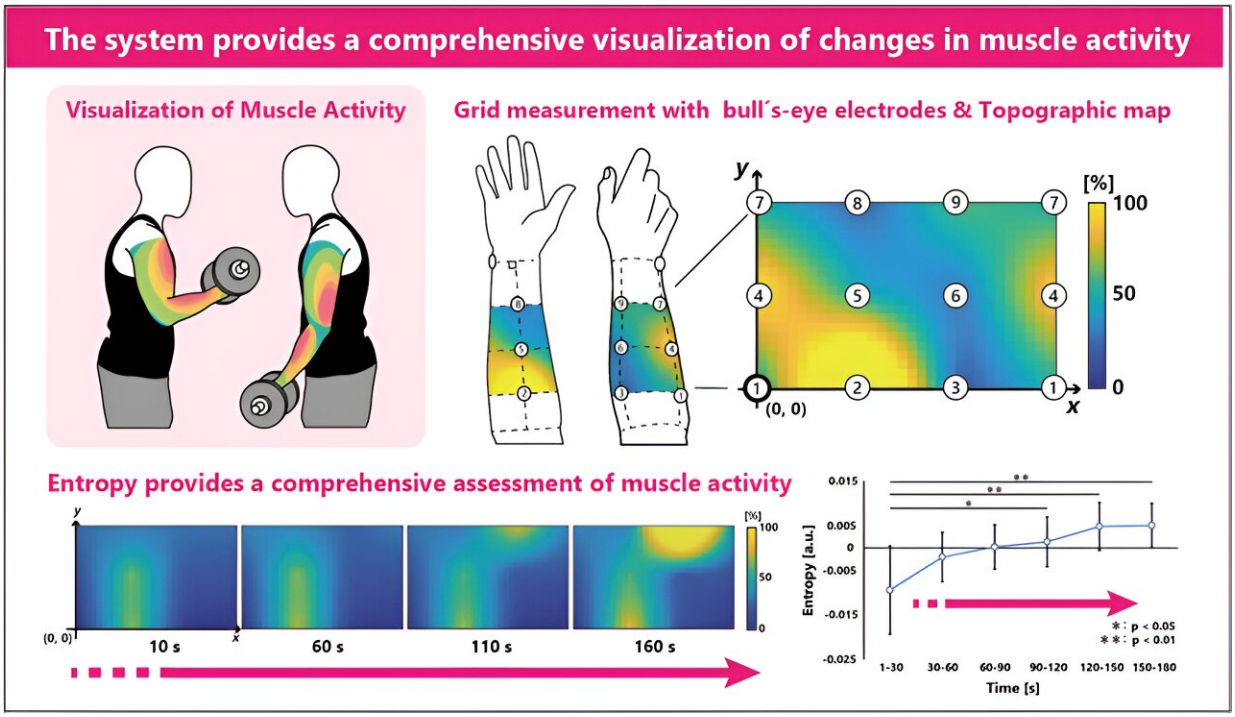

The traditional sEMG approaches are unable to evaluate the activity of multiple muscles at the same time. This is important to study the coordination of muscles in the human body. To overcome this limitation, researchers from Japan have established a novel measurement system and demonstrated its effectiveness. Credit: Ms. Megumi Shimura and Dr. Yoshihiro Shimomura, Chiba University, Japan

Surface electromyography (sEMG) is a traditional method used to

measure the electrical activity of muscles during physical activity. This method has remained unchanged for over 70 years and involves the use of two standard approaches.

The first involves a pair of electrodes—metals that conduct electricity through non-metals—to record from a particular muscle, while the second employs a grid of electrodes arranged in a small rectangular layout in order to measure the potential distribution of intra-muscle activity. However, these approaches only provide a measurement of a single muscle at a time. Thus limiting our understanding of how our muscles coordinate while carrying out various physical activities.

In a new study published in the *Journal of Physiological Anthropology*, Professor Yoshihiro Shimomura of the Design Research Institute, Chiba University, along with a team of researchers, demonstrated the use of bull's-eye electrodes to evaluate the activity of multiple muscles at the same time and investigated its ability to assess fatigue and develop visuals of muscle coordination during a grasping task.

His team included Ms. Megumi Shimura and Mr. Akihiko Mizumoto from the Graduate School of Science and Engineering and Dr. Yali Xia from the Design Research Institute, Chiba University.

"Ours is the first study to provide images of muscle coordination in the human body and to revolutionize the existing methodology of electromyography," explains Dr. Shimomura.

The researchers enrolled nine adults without any injuries or health issues for this study. The participants were asked to perform a grasping task. In this task, a pulley system with a handle at one end and a weight at the other end was employed, and the participants were instructed to grasp the handle with the hand most frequently used without moving the forearm. During the task, the bull's-eye electrode measured the activity

of muscles. The performance of this system was assessed using root mean square and entropy—a measure of the disorder of a system.

The findings suggest that an increase in entropy over time indicates an increase in the disorder of forearm muscle due to fatigue. In addition, bull's-eye electrodes provided an image of muscle activity at nine different points. Thus, the study forms a base for further development of a multichannel sEMG system to increase the scope of measuring muscle activity. "Although our bull's-eye electrode system has some limitations such as electric gain, it is a robust system that illustrates the muscle activity due to fatigue," says Dr. Shimomura

Dr. Shimomura concludes, "Having access to an electromyogram can aid in the treatment of muscle disorders of people working in urban lifestyles and improve the health of elderly people. It can also successfully transform the use of one's body to improve the health and quality of life. Going forward, being able to better understand our electromyogram is likely to change the way we use our bodies and enhance our well-being."

More information: Megumi Shimura et al, Multipoint surface electromyography measurement using bull's-eye electrodes for wide-area topographic analysis, *Journal of Physiological Anthropology* (2023). DOI: 10.1186/s40101-023-00342-3

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