OPTIMIZED SPECKLE TRACKING ALGORITHM FOR ESTIMATING FASCIAL LAYER MOVEMENT IN ULTRASOUND

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Fascia is a complex, interconnected tissue that encapsulates organs, muscles, and tendons. Until recently, fascial dynamics could not be studied *in vivo*, but advancements in ultrasound imaging now allow the noninvasive study of fascia. Understanding the movement of fascial layers relative to each other and fascia relative to muscle tissue could provide critical insights into biomechanics and musculoskeletal health. This research represents the first measurement of fascia translation *in vivo*.

Ultrasound videos were collected using identical scan depth (1.5 cm), transducer frequency, and scan location on 10 subjects. The fascia on the quadricep muscle was scanned, due to a large surface area and the ability to collect high-resolution ultrasound images. Data collection was conducted at the Department of Rehabilitation and Sports Medicine at Charles University in Prague. An algorithm was designed to track fascial movement from frame to frame in an ultrasound cine loop. The algorithm was coded in a custom program made in MATLAB that measures the similarity between portions of frames in the loop. Similarity measurements were made by looking at the speckle pattern corresponding to the fascia in the ultrasound image. These measurements were done by calculating the correlation in speckle pattern from frame to frame, using the Sum of Absolute Differences metric. As the program tracked a specified spot, or kernel, throughout the scan, its coordinates were recorded. A graph was then produced showing the position of the kernels on each fascial layer over time. Movement was tracked only in the horizontal direction due to the negligibility of vertical displacement. The maximum inter-layer displacement within a single video frame was then reported within the program.

Ten scans were analyzed, each reporting values for the maximum displacement between layers of deep fascia, and between deep and superficial fascia layers. The average maximum displacement between layers of deep fascia was 0.67 mm, with a standard deviation of 0.31. The average maximum displacement between superficial and deep layers of fascia was 1.77 mm, with a standard deviation of 0.79. The average ratio of the superficial-deep layer displacement to the deep-layer displacement was 3.47.

The MATLAB algorithm showed success in accurate tracking of the different fascia layers, measuring their displacement over time in scans. This algorithm offers us more insight into the role that fascia plays in the body. The ability to study the dynamic abilities of fascia *in vivo* paves the way for future biomechanical research.