Noninvasive Measurement of Fascia Thickness in Porcine Models for Investigating Myofascial Pain Using Single- Sided NMR

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Introduction: Myofascial Pain Syndrome (MPS) is a chronic disorder marked by muscle pain and fascial stiffness yet lacks objective diagnostic tools—contributing to opioid overuse and unreliable treatment approaches like acupuncture. Fascia densification, a key feature of MPS, may serve as a useful biomarker. This study investigates single-sided NMR as a noninvasive technique to measure fascia thickness and identify MPS biomarkers in porcine models, chosen for their anatomical similarity to humans.

Methods: Thoracolumbar tissue samples from 12 pigs (ages 11–18 months) were collected post-mortem with fascia intact. Fascia thickness was assessed noninvasively using a single-sided NMR device (NMR-MOUSE PM25, 13.19 MHz, Magritek) at 27 °C, acquiring T_1, T_2, and diffusion data. Signal analysis was performed in MATLAB using both exponential and stretched exponential models. Validation methods included optical imaging with SYBR Gold and Eosin staining analyzed in FIJI, and ultrasound imaging (Vevo 2100, 21 MHz) for comparison.

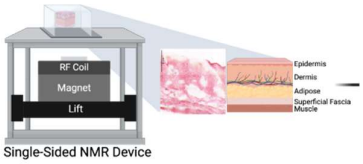

Fig. 1:Cross-sectional schematic of NMR sampling geometry, illustrating layered tissue structure from epidermis to muscle.

Results and Discussion:

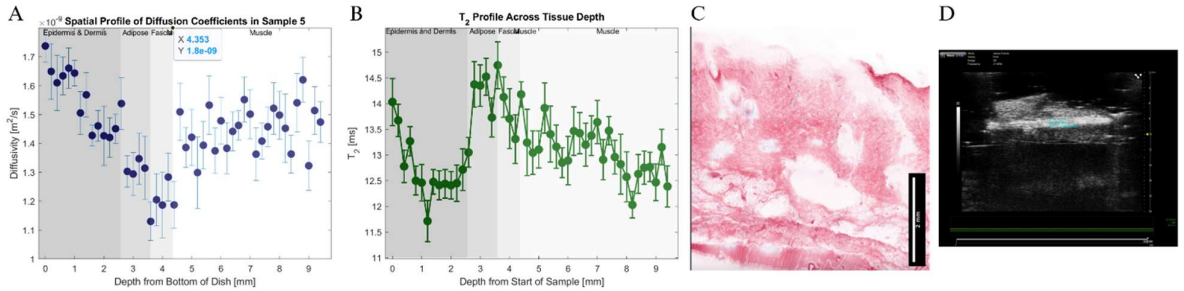

Fig 2: (A) Diffusion coefficients in m^2/s as a function of depth, with the known depth measurements overlayed. (B) T2 graph in seconds versus the depth of sample with the known depths overlay. (C) Example of optical imaging of sample, serving as ground truth. (D) Ultrasound image of sample, showing sample layers.

Conclusion: Single-sided NMR revealed clear, depth-dependent changes in tissue properties. T_1 values decreased at the fascia boundary, while T_2 values dropped within the fascia, reflecting structural shifts. Diffusion coefficients showed a characteristic dip before the fascia and rose within it, indicating a transition zone. In contrast, ultrasound provided poor delineation due to weak contrast between fascia and surrounding fat. These results suggest that relative changes in NMR signals across depth, rather than absolute values alone, offer a promising approach for identifying fascia and assessing its thickness noninvasively.

References:

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