

Anatomical Mapping of Dorsal Hand Fascial Layers: High Resolution Ultrasonography and EXAKT System Analysis for Optimizing Filler Injection

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INTRODUCTION

Anatomical Background

The superficial fascia of the dorsal hand forms a complex three-dimensional network that remains underexplored in anatomical literature. Conventional histological methods often distort the delicate fascial architecture due to processing artifacts, hindering accurate understanding of true anatomical relationships.

The EXAKT system, with its precision tissue sectioning and resin embedding capabilities, preserves subtle fascial boundaries often lost in conventional paraffin-based histology. This advanced technique enables accurate visualization of the intricate connective tissue organization in the dorsal hand.

Current Clinical Challenge

Current filler injection techniques primarily rely on surface landmarks and practitioner experience rather than imaging-guided fascial mapping. This limitation can result in:

- Unpredictable filler distribution
- Increased risk of complications
- Insufficient anatomical understanding of fascial structures
- Absence of zone-specific injection guidelines

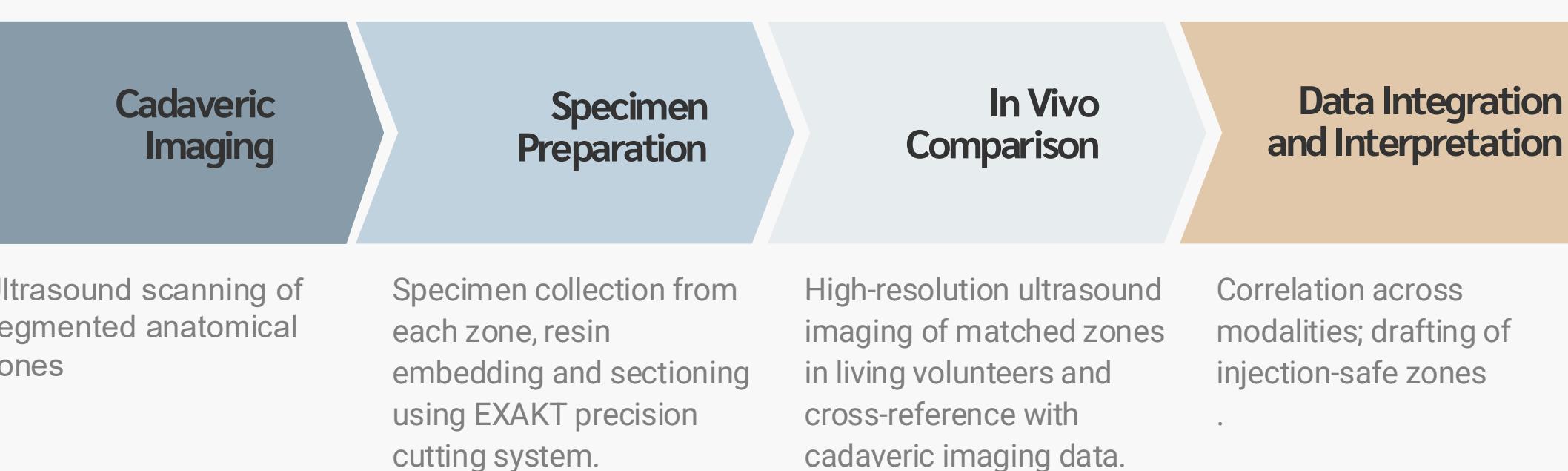
Research Gap

By establishing a precise correlation between ultrasonographic findings and histological architecture, this study aims to bridge the gap between clinical imaging and anatomical reality. Through a zonal analysis approach, we examine region-specific variations in fascial configuration and aim to generate image-guided anatomical reference data currently lacking in the literature.

METHODS

Study Design

Prospective, non-interventional anatomical imaging study employing cadaveric dissection, ultrasonography, and histological analysis.



Materials

- Two Cadaveric hands for comprehensive anatomical analysis
- Four anatomical zones per hand (from wrist to MCP joint)
- Living volunteers for in vivo ultrasound correlation
- Systematic sampling across dorsal hand regions

High-Frequency Ultrasonography

- Frequency: 18-22 MHz
- Target: Real-time imaging of fascial layer configuration
- Application: Scanning of each predefined anatomical zone

EXAKT System Analysis

- Resin embedding and precision sectioning
- Undecalcified tissue processing
- Minimal artifact distortion



CONCLUSION

By combining high-resolution ultrasonography with precision-preserved histological sections via the EXAKT system, this study offers novel anatomical insights into the dorsal hand's fascial architecture.

A continuous, region-specific fascial network was identified, challenging the conventional view of discrete, layered fascial structures. These findings serve as a foundational reference for improving anatomical understanding and informing future research.

While clinical translation remains in progress, the integration of imaging and zonal mapping may support the development of safer and more tailored injection protocols in the future.

This integrated approach offers a promising direction for enhancing anatomical visualization of the dorsal hand that reflects real-world structural variability.

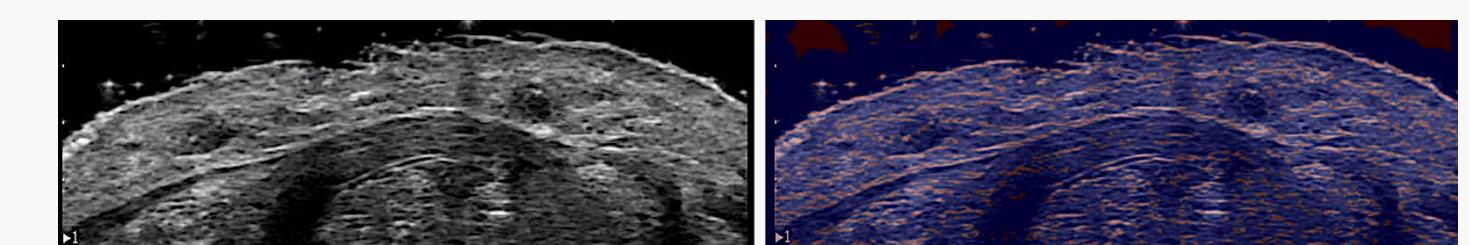
RESULTS

EXAKT System Histological Analysis

revealed superior preservation of fascial architecture across the following regions:

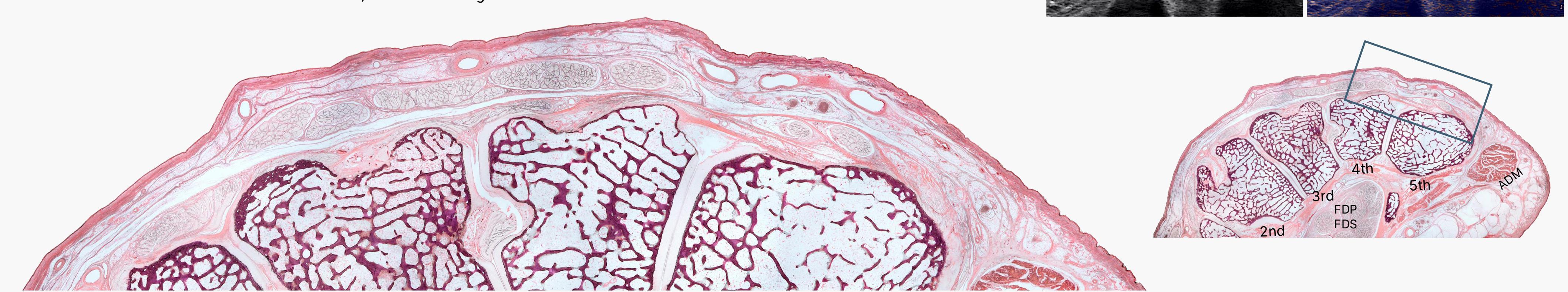
Zone 1 (Wrist Level - Radiocarpal Joint)

- Carpal bone including the Scaphoid, Lunate Triquetrum were clearly visualized
- Extensor compartments (EDC, ECU, EDM) showed well-preserved fascial boundaries
- Distinct superficial and deep fascial planes were identifiable



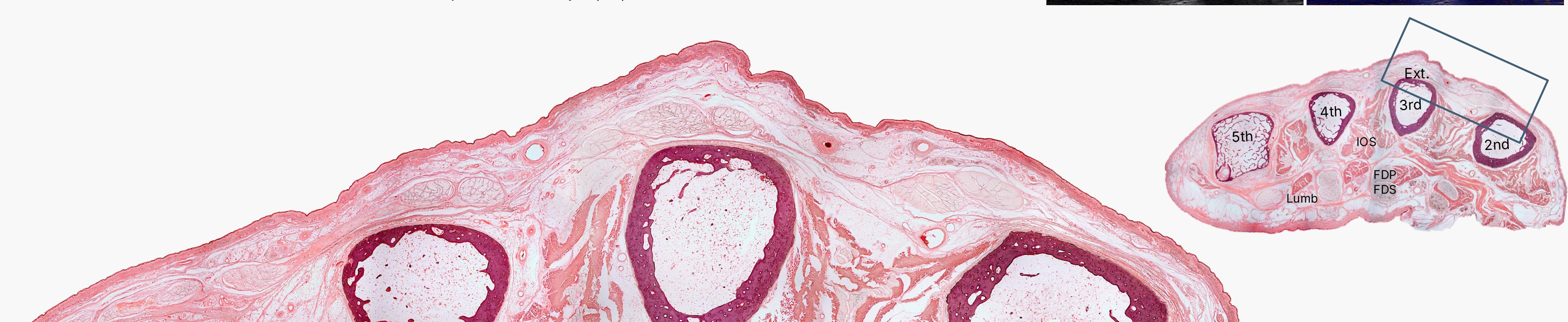
Zone 2 (Mid-Metacarpal Level)

- The 2nd to 5th metacarpals and their surrounding soft tissues were evaluated
- Neurovascular bundles were located between the subcutaneous tissue and the deep fascial layer
- The fibrous architecture exhibited an interwoven, mesh-like configuration



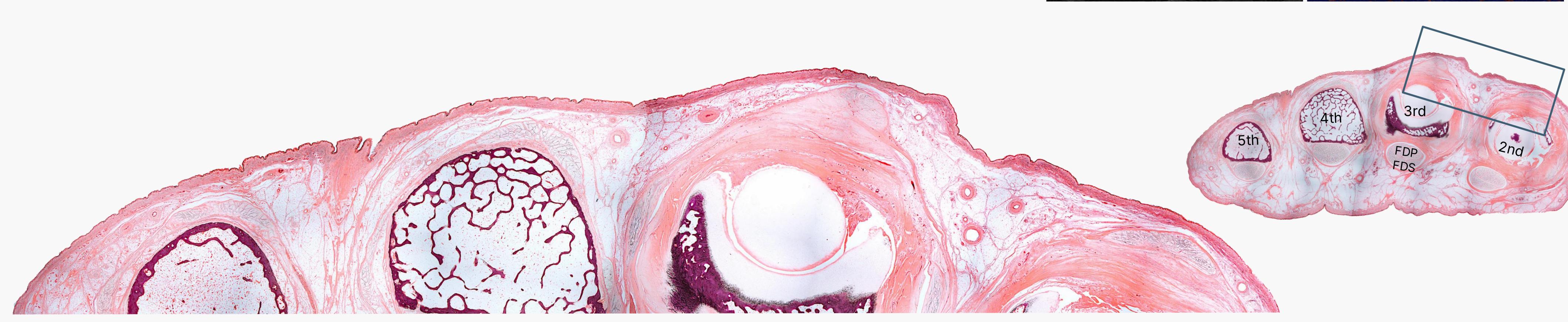
Zone 3 (Thenar Web Space Level)

- The superficial branch of the radial nerve (SBRN) consistently traverses this zone, particularly within the first dorsal web space
- Both extensor tendons (e.g., EPL, EDC) and dorsal interosseous muscles were identified within a shared fascial layer
- Neurovascular structures were also visualized within the deep intermediate layer (DIL)



Zone 4 (Metacarpophalangeal Joint Level)

- The age-related soft tissue atrophy in this zone often results in increased prominence of superficial veins and extensor tendons.
- Superficial fascia was notably thinner at the MCP joint level, with less distinct separation between fascial layers.
- The fascial continuity remained evident, supporting the concept of an integrated fascial network across the dorsal hand



The findings revealed a continuous fascial network, countering the traditional view of segmented layers and highlighting a more unified anatomical organization.

In Progress Automated detection & quantification of fascial layers

In Progress Development and validation of advanced image processing algorithms

Completed High-frequency ultrasound with multimodal image enhancement

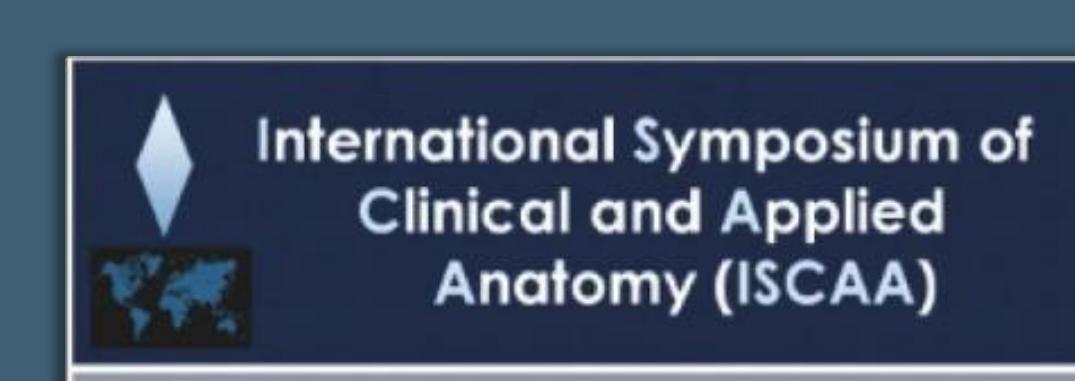
Completed Zone-specific histology using H&E and Toluidine Blue stains

Ongoing Analysis

FUTURE RELEVANCE

Long-term Clinical Translation Potential

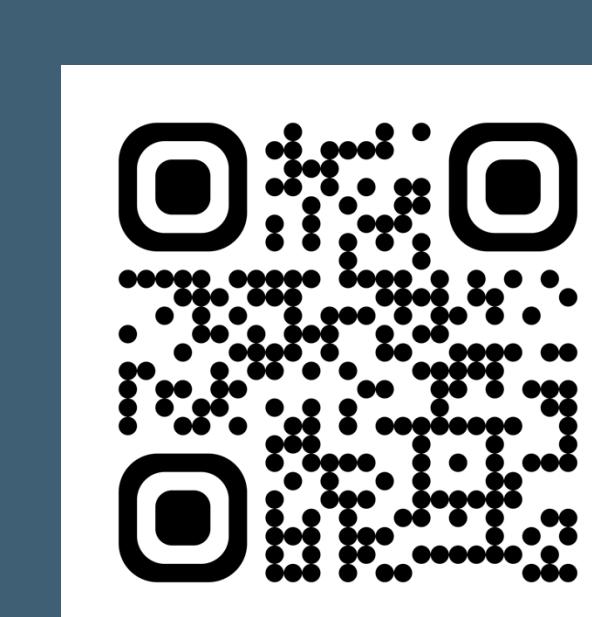
1. Personalized anatomical assessments reflecting individual fascial variability
2. Enhancing safety through deeper understanding of fascial complexity and individual differences
3. Adaptive injection protocols guided by real-time fascial architecture evaluation
4. Risk stratification based on individual fascial network patterns
5. Personalized treatment approaches that recognize significant anatomical variability



SCAN TO EXPLORE

Visit my website for:

- ✓ Real-time ultrasound filtering demos (e.g. Hessian, DoG, Grad-CAM)
- ✓ Streamlit-based apps for anatomical layer enhancement
- ✓ project updates and Sample codes



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