High-Frequency Ultrasound Imaging of the Hand: A Pilot Study

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BACKGROUND

Ultrasonography is a cost-effective, non-invasive, and expedient imaging modality with wide clinical applications. Conventional ultrasound uses transducers with frequencies that range from 5-12 MHz. These relatively low frequencies allow for penetration deep into the body to visualize target internal structures. High-frequency ultrasound (HFUS) is capable of producing frequencies up to 70 MHz. Such high frequency provides superior imaging of superficial anatomical structures with tissue resolution up to 30 microns. Our investigation focuses on the imaging capabilities of HFUS for the superficial structures of the hand including nerves, tendons, arteries, and veins. To date, only a single human study has been published on the use of HFUS imaging of the hand at frequencies greater than 20 MHz.

METHODS

The Vevo® 2100 (VisualSonics, Toronto, Canada) imaging system was used to perform all ultrasound exams. Four unique linear array transducers were employed. They include the following: MS250 at 13-24 MHz, MS400 at 18-38 MHz, MS550S at 32-56 MHz, and MS550D at 22-55 MHz. All studies were performed by the authors who have no formal training in ultrasound techniques. Additionally, all studies were performed on healthy volunteers under IRB approval.

RESULTS

A series of static images and dynamic, real-time videos were obtained at various locations within the hand. Structures as large as tendons and as small as individual fascicles of the digital nerves were successfully identified. Examples of findings include, but are not limited to, the following: 1) the median nerve and its individual fascicles at the proximal wrist and carpal tunnel, 2) the insertion of FDP onto the distal phalanx (Figure 1), 3) the flexor tendons, phalanx, digital artery and nerve in finger cross-section views (Figure 2), 4) real-time motion capture showing the movement of the slips of FDS moving dorsolateral to FDP with finger flexion, 5) the extensor tendons and dorsal extensor compartments of the wrist, and 6) the intimal layer of the radial artery (Figure 3).

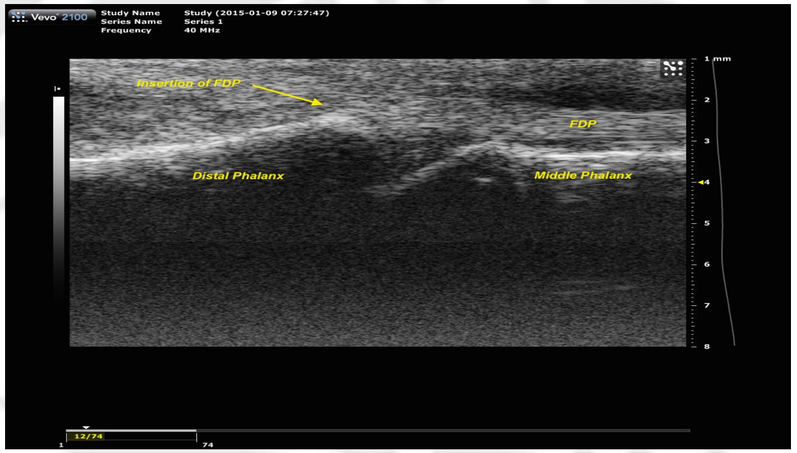

Figure 1
Longitudinal section of middle finger at the DIPJ showing the insertion of the FDP tendon onto the distal phalanx

Figure 2
Cross-section view of middle finger at the level of the proximal phalanx showing the two slips of FDS overlying FDP and the digital artery and digital nerve

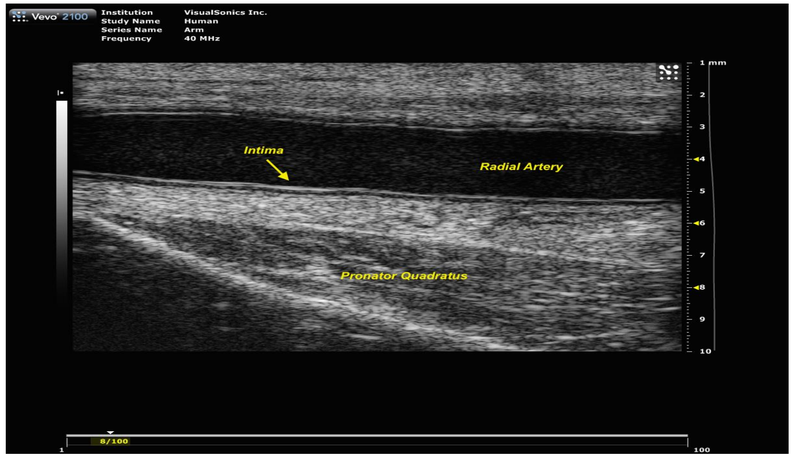

Figure 3
Longitudinal section of the radial artery at the distal forearm showing the intimal layer of the arterial wall

CONCLUSIONS

HFUS is both a feasible and clinically significant imaging modality for hand surgeons. Our investigation shows that HFUS exhibits diagnostic promise for multiple hand pathologies including neural, vascular, and tendinous injuries in both acute and chronic settings. Further study is needed to better define the capabilities of HFUS and its clinical potential for the hand.

REFERENCES

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