Procedure-Oriented Torsional Anatomy of the Hand for Spasticity Injection

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Objectives: To provide musculoskeletal ultrasound (MSKUS) images of hand anatomy in the position of hemiparetic flexion as a reference for spasticity injections. After a stroke, spasticity can result in anatomic distortion of the hand. Spasticity may require treatment with botulinum toxin or phenol injections. Anatomic distortion may decrease the accuracy of injections. Standard anatomic references are of limited utility because they are not in this spastic hemiparetic position. There presently is no anatomic reference in the literature for these spastic postures. This study is part three of a series examining torsional anatomy of the body.

Design: Ultrasound (US) images were obtained in a healthy subject. The muscles examined included the lumbricals and the flexor pollicis brevis. A marker dot was placed at each dorsal and palmar anatomic injection site for these muscles. The US probe was placed on these dots to obtain a cross-sectional view. A pair of US images was recorded with and without power Doppler imaging: the first in anatomic neutral and second in hemiparetic spastic positions. In addition, a video recording of the movement of the muscles during this rotation was made at each site.

Results: On the palmar view, the lumbricals rotated medially. On dorsal view, the lumbricals can be seen deep to the dorsal interossei muscles, with spastic position, and they become difficult to identify. The flexor pollicis brevis (FPB) muscle contracts with torsion, making abductor pollicis brevis (APB) predominately in view.

Discussion: The anatomic location of the lumbrical muscles makes them difficult to inject even with ultrasound guidance. However, recognizing the nearby digital vasculature allows for improved identification of the musculature for injection purposes. The FPB muscle also can be identified by its adjacent radial artery lateral to the flexor pollicus longus tendon.

Conclusion: Normal anatomy of hand can become distorted in spastic hemiparesis. Diagnostic ultrasound is able to discern these anatomic locations if the sonographer is competent in recognizing the appearance of normal anatomy and is skilled in resolving the visual changes that occur in spastic hemiparesis. The authors hope this series of images will increase the accuracy, safety, and efficacy of spasticity injections in the hand.

Key Words: hand, spasticity, spasticity block, injection, anatomy

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Spasticity, often a result of stroke or traumatic brain injury, can affect the hand, leading to deformity, hygiene issues, and macerated skin of the palm. This condition may require treatment with injections, such as botulinum toxins. Although phenol injections may be utilized, they are less commonly performed in the upper extremity. This paper is part of a series of papers examining torsional anatomy in the upper extremity. Typical references for the anatomy of muscles are in anatomic neutral, providing limited utility for treating patients in a spastic hemiparetic position. Muscles typically injected in the hand for spasticity include the lumbricals and flexor pollicis brevis (FPB). The purpose of this article is to provide anatomically accurate schematics of hand anatomy in the position of pronated hemispastic flexion synergy relevant to needle procedures.[1]

METHODS

This project was approved by the local institutional review boards of the academic medical school and the hospital. Informed consent was obtained before the start of the study from the subject. MSKUS images were obtained in a healthy, 50-year-old female subject. Marker dots were placed over the commonly injected hand muscles (Fig. 1): lumbricals on the dorsal and palmar aspect and FPB according to the classic electromyographic muscle injection manual by Delagi.[2] The MSKUS probe was placed over the center dot for the lumbrical muscles to obtain a cross-sectional view. On palmar view, the left side of the screen correlates to the radial aspect; on dorsal view, the left side of the screen correlates to the ulnar aspect. For the thenar muscles, left of the screen is ulnar. A pair of MSKUS images was recorded with and without power Doppler imaging: the first in supinated anatomic neutral (Fig. 1, Anatomic Neutral) and second in hemispastic pronation and flexed fingers position (Fig. 1, Hemispastic Flexion). The images were compared side to side. In addition, a video recording of the rotation of the muscles was made at each site to track the movement of the muscles. Cross-sectional ultrasound images were displayed as they appear in imaging projections. Color coding was used to emphasize the approximate locations and extents of needle procedure targets (blue; muscles) and structures to be avoided (red: vessels, nerves, and tendons; gray: muscles). Anatomic and MSKUS references were used to identify muscles in anatomic neutral position, which helped track their movement on cine loop with pronation and flexion (Netter,[3] Hayman,[4] Jacobsen,[5] Bianchi,[6] Gilroy,[7]).

RESULTS

In palmar view (Fig. 1A, Anatomic Neutral), the lumbricals (blue) are visualized on either side of the flexor digitorum superficialis and profundus tendons (red), deep to the digital artery (red outline) which is easily located with Doppler (Fig. 1A, Anatomic Neutral, Vascular). On pronation and finger flexion, the lumbricals (blue) contract and move medially (Fig. 1A, Hemispastic Flexion). On dorsal view (Fig. 1B, Anatomic Neutral), the lumbricals (blue) can be seen deep to the dorsal interossei muscles (gray) (Fig. 1B, Anatomic Neutral). In hemispastic position, it becomes more difficult to identify their movement (Fig. 1B, Hemispastic Flexion). However, with Doppler, the digital artery can

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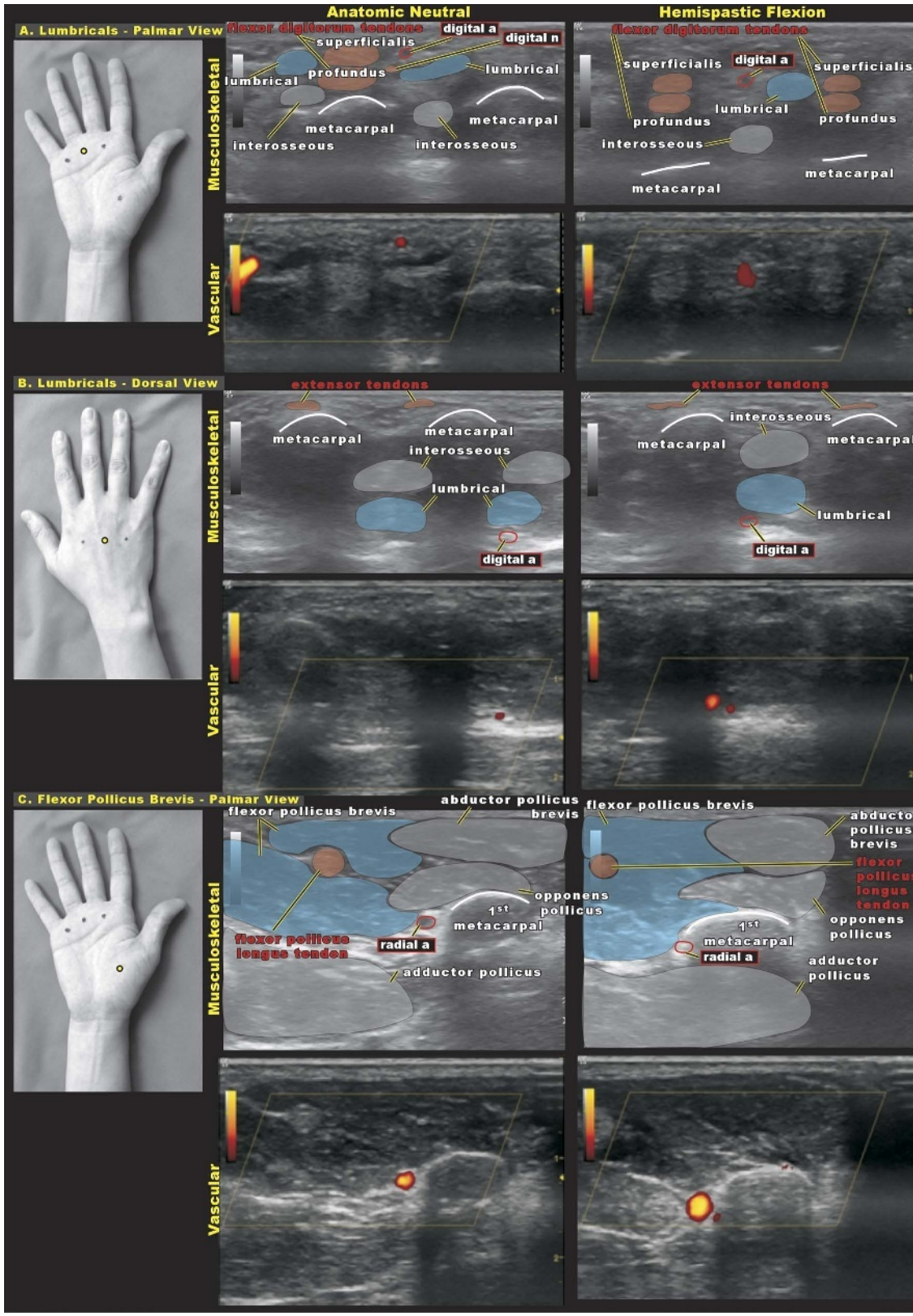

FIGURE 1. Comparison of anatomic neutral (left) and hemispastic flexion view (right) of ultrasound sections (A–C) of the normal hand highlighting musculoskeletal view of key structures and vascular view (used with power Doppler imaging) for identification of nearby vasculature. Color is used to identify key injection targets (blue: muscles) and structures to avoid (red: vessels, nerves, and tendons; gray: muscles). The open dot over the picture of the hand indicates probe placement.

be easily visualized, making the location of the lumbrical muscle easier to estimate (Fig. 1B, Vascular).

In the palmar view (Fig. 1C, Anatomic Neutral), the muscle bellies of the FPB (blue) surround the flexor pollicis longus tendon (red). The superficial palmar branch of the radial artery (red outline) lies deep to the FPB at the level of the first metacarpal, as clearly visualized with Doppler (Fig. 1C, Vascular). The FPB contracts with torsion, bringing the abductor pollicis brevis (APB, gray) predominately in view (Fig. 1C, Hemispastic Flexion). Of note, the radial artery (red outline) moves deeper with the torsion of the FPB and becomes more prominent on Doppler (Fig. 1C, Vascular).

DISCUSSION

Torsional Concepts

Through study of torsional anatomy in each anatomic area, the authors have learned a few general concepts. In the hand, there is a torsional change in anatomy and vascular changes that are helpful in identifying nearby muscles.

Effect of Torsional Positioning on Targeting Muscle Injections in the Hand

In this study, it was found that the lumbrical muscles are easier to identify on the palmar aspect (Fig. 1A). However, a dorsal injection approach may be more realistic given hand positioning, the ability to properly clean before an injection, and the location of the digital artery directly over the muscle belly in a spastic position (Fig. 1A, Vascular). This injection approach may benefit from using the probe on the palmar aspect, if possible, to appropriately identify the target lumbrical muscle bellies. Alternatively, using dorsal probe placement with Doppler to visualize the digital arteries makes the region where the lumbricals reside identifiable. An inadvertent injection into the interossei muscles would not affect finger flexion at the metacarpophalangeal joint. Accidental injection into the digital nerves can be quite painful, which may be avoided using Doppler imaging to avoid neurovascular structures.

At the FPB muscle injection site, the FPB contracted medially and was replaced by the APB superficially (Fig. 1C, Hemispastic Flexion) and with deeper needle advancement, the opponens pollicis (OP) muscle. An inadvertent injection into the APB or the OP would not affect thumb flexion. Injection into the radial artery is a concern with deep needle placement. Using Doppler guidance can help avoid vascular structures and help identify the FPB (the radial artery also rotates with the FPB) (Fig. 1C, Vascular).

Complications

Complications from botulinum toxin injections reported in the literature were reviewed in the first paper Chiou-Tan et al[8] and are summarized here. These include arm pain, hematoma,[9] dry mouth,[10,11] hypertonia, peripheral edema, injection site pain, nausea,[12] muscle weakness, dysphagia, cough, myalgia,[13] fatigue, pyrexia,[14] and iatrogenic botulism.[15] Focal complications such as infection are rare with botox injections as well as hand injections into the palm,[16,17] although current literature review does not discuss botox injections into a macerated or malodorous palm. However, the authors agree that injection into macerated, erythematous, malodorous skin or an area that is not able to be appropriately cleaned before injection (such as in some cases of severe focal hand spasticity) should be avoided.

Conclusions

This article is the third in a series introducing "torsional" anatomy.[8,18] The goal is to identify anatomic changes that occur with torsion to improve the accuracy, safety, and efficacy of injection procedures as it relates in the spastic hand.

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