The Applications of Ultrasonography in Biomechanical Investigation and Clinical Practices in Hand Surgery

I-Ming Jou, M.D.
Academic Vice Superintendent, E-Da Hospital
Professor, Orthopedics department, E-Da Hospital; Medical College, I-Shou University.

Ultrasonography is widely available in many departments and with the advantages as providing dynamic images in real time, and capability of identification of soft tissue bone or lesion, and without radiation exposure. Recent reports have also noted that ultrasonography guided percutaneous surgical intervention have gain popularity as an effective, safe, and less-invasive alternative to open invasive operations in general, gynecological and obstetrical procedures. However, it has only received anecdotal use of musculoskeletal fields, including the hand surgery.

We propose a novel operative technique for reduction of distal radial fracture, percutaneous release of the trigger digit (TD) and carpal tunnel syndrome (CTS) using real-time ultrasonographic guidance since 1998. This sonographically assisted percutaneous release (SAPR) provides the advantage of direct visualization of the release and avoids the inherent risks of incomplete release and injury to adjacent neurovascular structures associated with current percutaneous release techniques.

In this talk, I will present our several attempts in cadaveric and clinical studies to determine whether the real time and dynamic multiple-plane observation capabilities of ultrasonography would allow us to see and precisely monitor the percutaneous division of the A1 pulley/transverse carpal ligament and, therefore, avoid the inherent risks combined with the reported minimal invasive release (e.g. blind percutaneous or endoscopic release). In addition to the benefits of a shorter period of disability and less postoperative discomfort for the patient, this tech also valuable for the simplicity for the surgeon (need only local infiltrative anesthesia, no assistant or tourniquet is needed for the percutaneous release).

In summary, because of the effectiveness of these techniques, we have undertaken over fifteen thousands cases of trigger digit and carpal tunnel syndrome. In addition to the beneficial results in clinical practice, the rapid accumulation of these cases has also brought several basic studies on these disorders. One of our research is tendinosis might change the biomechanical properties of the tendon.
Therefore, trigger finger might affect biomechanical behaviours of the flexor digitorum tendons. Ultrasonography provides not only the morphology and pathology information of tendon but also the biomechanical behavior information of tendon in vivo. During the limb movement, ultrasound is commonly used to track the tendon motion. The biomechanical behavior of the tendon can be estimated via the ultrasonography information in the B-mode image and the torque of action muscle. It is important to provide a reliable biomechanical information of flexor digitorum tendons in trigger finger via a non-invasive measurement. Our study developed a software to automatically track the motion of flexor digitorum tendons and a custom isokinetic dynamometer to calculate the flexor digitorum tendons’ force during the movement of finger flexion. The results showed that the higher tendon stiffness in TF patients was observed than those of the controls in this study. The proposed method accurately tracked the motion of tendons in vivo. This study provides valuable information regarding the biomechanical behaviors of flexor digitorum tendons in trigger digit via measuring the dynamic ultrasonography of flexor digitorum tendons and tendon force.