Editorial Commentary: Artificial Intelligence for the Wrist: Moving to the Forefront of Diagnostic Imaging for Triangular Fibrocartilage Complex Injury

Julia A. V. Nuelle, M.D., Editorial Board

Abstract: Accurate diagnosis of the etiology of ulnar-sided wrist pain and injury to the triangular fibrocartilage complex, particularly Palmar 1B tears, can prove to be challenging. Multiple peer-reviewed studies have demonstrated that accurate diagnosis and treatment of tears of the triangular fibrocartilage complex through nonoperative and operative means, including arthroscopy, can result in improved patient outcomes and function. One of the keys to successful treatment, however, is accurate diagnosis. While our current imaging modalities help to provide additional data for the assessment of this pathology, magnetic resonance imaging and computed tomography scans have limitations. Thus, employing the power of artificial intelligence and deep learning to ultrasound assessment of this injury is appealing. Efficient integration of this technology into daily practice has potential to bolster diagnostics not only in large medical centers but also in underserved areas with limited access to magnetic resonance imaging and computed tomography.

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Despite incredible advances in imaging technology, accurate assessment of pathology of the triangular fibrocartilage complex (TFCC) before proceeding with arthroscopy can be a diagnostic challenge. Multiple peer-reviewed studies have demonstrated that accurate diagnosis and treatment of tears of the TFCC through nonoperative and operative means, including arthroscopy, can result in improved patient outcomes and function.[1-5] One of the keys to successful treatment, however, is accurate diagnosis. Our current clinical options to evaluate ulnar-sided wrist pain beyond history, physical examination, and radiographs include magnetic resonance imaging (MRI) and computed tomography (CT) with and without arthrogram. Many institutions can now boast 3.0-Tesla MRI capability, giving increased resolution in preoperative assessment of these injuries. However, even with this enhanced resolution, tears can be missed.[6] The more-common 1.5-Tesla MRI has reported sensitivity and specificity of diagnosing TFCC tears of 68% and 60%, respectively, reflecting the decrease in resolution of the images as compared with the more enhanced machines. The addition of arthrography, although invasive, can improve the diagnostic sensitivity to 95% and specificity to 100%, as Petsatodis et al.[7] reported. Computed tomographic arthrogram (CTA) is also an option, but as Treiser et al.[8] note, the sensitivity and specificity (0.89 and 0.89) are also lacking for the diagnosis of TFCC tears with peripheral tears, such as Palmer 1B, more difficult to identify on CTA than central tears.[9] Beyond the limitations in diagnostic accuracy, the arthrogram is an invasive procedure, which is not without risk. Additionally, MRI and CT are expensive, and CT scans require radiation exposure for the patient.

Given these shortcomings with our current standard of care assessments and the burgeoning promise of ultrasound (US) in the evaluation of these lesions, it is with great interest that I read “Ultrasound With Artificial Intelligence Models Predicted Palmer 1B Triangular Fibrocartilage Complex Injuries” by Shinohara, Inui, Mifune, Nishimoto, Mukohara, Yoshikawa, and Kuroda.[10] Using a technique known as deep learning (DL), which has been investigated in other areas of medical

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imaging, the authors assessed the ability of artificial intelligence technology to accurately learn and then diagnose Palmar 1B TFCC tears using US. To investigate this, 15 volunteers with 29 asymptomatic wrists (control groups) and 17 patients with 20 symptomatic wrists and known Palmar 1B TFCC tears diagnosed with either MRI or CTA and confirmed by arthroscopy (injury group) were included in the study. US was performed on all subjects with the wrist in varying degrees of radial and ulnar deviation. The authors then cropped a 15-mm × 15-mm area that included the articular disk and prepared 2,000 images for each group. Eighty percent of these images were used for training data for 3 models typically used in medical imaging: GoogLeNet, ResNet50, and ResNet101. The remaining images were used as test data. Using these 3 learning models, a sensitivity of 1.00 and specificity of 0.78 for correctly diagnosing Palmar 1B TFCC tears was found. As the authors suggest, this has potential to serve as a screening tool for patients with ulnar-sided wrist pain and an examination concerning for TFCC tear.

As most innovative research does, this study creates as many questions as answers. Translating this work to clinical practice is a critical next step. With the current study, 3 systems were used to achieve the stated results. Deciphering the focus of each of the 3 learning models to successfully achieve the determination of injury versus control and incorporating those elements and coding into a single learning system could provide more feasibility to health care systems wanting to employ this technology into clinical practice. Further, the data from the occlusion sensitivity in the present study could be used to enhance a unified learning model to allow for increased specificity in the diagnosis of Palmar 1B TFCC tears.

The potential clinical impact of incorporating artificial intelligence and DL into assessment of TFCC tears as well as other musculoskeletal pathology is potentially limitless. This work demonstrates we are on the cusp of an exciting time in the field of musculoskeletal diagnostic imaging, which will in turn improve our ability to effectively identify patients who may benefit from arthroscopic interventions. As data-processing speeds continue to advance and the development of code that allows for programs to learn from data presented, we may find ourselves as surgeons having the ability to use less-expensive and more portable imaging modalities to supplement our clinical practices, even in the assessment and diagnosis of otherwise-challenging pathology. This has the potential to reach far into otherwise-underserved areas in the United States and around the world where access to MRI, CT, and arthrograms are limited. Beyond the clinical applications, leveraging the dynamic nature of US and combining it with DL has the potential to give us insight into subtle radiographic differences that human observers might not yet detect. This could give us further direction toward advancing our understanding of the complex pathology and biomechanics of the ulnar side of the wrist that we may then apply to our clinical practices.

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