Standards, innovations, and controversies in urologic imaging

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Urologic medical imaging, especially ultrasound, is an essential part of the daily clinical practice of urology. In the realm of cancer diagnostics and staging, new imaging modalities are emerging and older modalities are being adapted to new uses. Diagnostic imaging technology is transforming into a system which not only identifies lesions, but also attempts to predict their clinical relevance. Such a shift in functionality inevitably leads to controversy about the preferred imaging method. Comparing the new technologies to existing strategies and then evaluating outcomes with respect to efficacy and cost is occupying many investigators around the world. However, to be able to draw meaningful conclusions, these studies of efficacy need to be critically reviewed based not solely on specificity and sensitivity, but on plausibility and practicality. In this issue, “Standards, innovations, and controversies in urologic imaging,” the interplay between new technology and meaningful clinical advances is highlighted.

Many investigators agree that multiparametric MRI (mpMRI) is able to identify some prostate lesions not diagnosed on “systematic” biopsies. However, others present evidence that the rating system for mpMRI lesions (PI-RADS) has a high discordance rate between radiologists [1, 2] and that the decision to biopsy (or not) based on mpMRI findings may be significantly influenced by the technique and the interpretation by the radiologist. There is general agreement that highly suspicious lesions on mpMRI (PI-RADS 4 and 5) have a high likelihood of being cancer on targeted biopsy. It is also acknowledged that many of those

lesions could have been identified by Transrectal ultrasound (TRUS)-based urologic imaging at a fraction of the cost. In addition, evidence shows that when mpMRI is negative or if the lesion is less than or equal to PI-RADS 3, significant cancer is being missed [3].

TRUS of the prostate was the first imaging modality widely used to evaluate and biopsy the prostate [4]. TRUS-guided systematic biopsies (sBx) have been, and are, the standard in PSA-based prostate cancer detection [4, 5]. However, systematic biopsies, frequently called “TRUS biopsies” have little to do with modern, TRUS-targeted biopsies of the prostate. Many authors use inferior data from “systematic biopsies” to show the superiority of MRI-based biopsies. That oft-stated position is challenged by recent studies [6–8].

Today, modern high-frequency (7–29 MHz) TRUS with quantitative artificial intelligence analysis (ANNA) and multiparametric ultrasound (mpUS) have opened new pathways to objective image interpretation of the prostate [6]. These “radiomic” approaches are based on big-data analysis and provide information that is unavailable by visual interpretation. Multimodal, mpUS approaches have been introduced, allowing detection and biopsy guidance with excellent results [7–10]. Some individual ultrasound technique parameters are performing better than some individual parameters of mpMRI [6–10].

Novel ultrasound-based modalities (e.g., elastography, contrast-enhanced ultrasound, and computer-assisted ultrasound) are now available to urologists at a lower cost than cross-sectional imaging [8, 9, 11]. Some of these, notably computer-assisted analysis, sonoelastography and contrast-enhanced ultrasound, have been investigated and the promising results published [8–10]. It has been shown that targeted mpUS can achieve positive biopsy rates and significant cancer diagnosis rates equivalent to that seen using mpMRI targeted techniques in biopsy naive patients [10–13]. Data from a 12-year follow-up of the artificial intelligence protocol provides evidence of the possibility of monitoring patients by a big-data, artificial intelligence approach. This approach demonstrates a high likelihood (97%) of detecting significant cancer with less biopsies [11, 14]. There are, however, few

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high-quality studies on long-term outcomes associated with any of the currently available imaging modalities.

While the use of mpMRI targeting for second and subsequent biopsies has gained wide acceptance, multiple studies show that some significant cancers are missed altogether [3, 15–17] and that up to 26% of patients have at least one significant cancer missed by mpMRI when there are multiple lesions. Furthermore, there is evidence that mpMRI is insufficient to exclude significant cancer in the contralateral lobe of the prostate for patients undergoing focal therapy [17].

Staging and follow-up imaging in patients with prostate cancer has historically relied on CT and bone scans. Newer nuclear-based studies such as PET scan show some promise in supplementing or replacing those studies. Such a diagnostic tool would greatly enhance our staging accuracy and help to detect recurrence earlier [18].

Talented investigators and clinicians are challenging the status quo in imaging as the line between diagnosis and treatment continues to blur. Finding the proper role for new technology and refocusing developed technology in the context of patient safety, effectiveness, and cost will be the guiding principles for the next decade of imaging research.

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