

Fusion of MRI and TRUS Images for Targeted Biopsy of Prostate

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Transrectal Ultrasound (TRUS) guided biopsy relies on systematic sampling of the prostate and it is one of the main interventional methods for the diagnosis of Prostate Cancer (PCa) [1]. On TRUS, PCa foci usually appear as hypoechoic lesions in the peripheral zone (PZ) of prostate. However, the hypoechoic areas are not pathognomonic for PCa, as 39% of all the cancers are isoechoic and some may be hyperechoic [2]. This limitation of the grey scale ultrasound is the logic of not replacing current practice of systematic biopsies with TRUS guided targeted biopsies (of hypoechoic areas). Urologist are frequently presented with the dilemma of a patient who has had one or more negative prostate biopsies yet continues to have an elevated PSA or abnormal digital rectal examination. Often these patients have undergone multiple TRUS guided biopsies despite the well-documented decline in cancer detection with each successive biopsy [3].

In recent years, Magnetic Resonance Imaging (MRI) has emerged as powerful tool for diagnosis and staging of PCa. MRI allows an exact delineation of the zonal anatomy of the prostate, it's surrounding structures and thus improves the detection of cancerous lesions. Enhanced MRI techniques [dynamic contrast-enhanced MRI (DCE-MRI), diffusion-weighted MRI (DW-MRI) and magnetic resonance spectroscopy (MRS)] have further improved the diagnostic role of MRI. Pre biopsy MRI and real time TRUS images fusion (MRI/US fusion) targeted biopsies is an exciting technique to improve PCa detection especially in patients with prior negative biopsy. The cancer detection rates with MRI guidance are noticeably higher than TRUS, ranging from 38% to 59% [4]. Specific regions, such as the anterior part of the prostate, where more than 25% of carcinomas occur, are insufficiently sampled by TRUS due to limitations in range with this method [5]. MRI/US fusion allows the sensitivity and specificity of MRI to be combined with real time capabilities of TRUS. Multiple techniques exist for MRI/US fusion and include (1) direct "in bore" MR biopsies, (2) cognitive fusion, and (3) MRI/US fusion via software-based image co-registration platforms [6,7]. Pinto et al. developed a novel platform that fuses pre-biopsy MRI with real time TRUS imaging to identify and biopsy lesions suspicious for PCa [8]. They reported that the PCa foci localised on MRI were successfully targeted using this platform. Furthermore, MRI/US fusion targeted biopsy detected more cancer per core than standard 12-core TRUS prostate biopsies [8]. Similarly, Marks et al. observed that MRI/US fusion targeted biopsies

are 2-3 times more sensitive for detection of PCa than non-targeted systematic biopsies [7]. Additionally about 40% of men with Gleason score of 7 were diagnosed only by targeted biopsy and nearly 100% of men with highly suspicious MRI lesions were diagnosed with PCa [7].

MRI/US fusion allows urologists to progress from blind, systematic biopsies to biopsies, which are mapped, targeted and tracked. In future, MRI/US fusion targeted biopsy is likely to result in fewer and more accurate prostate biopsies than the present use of systematic biopsies with TRUS alone. However this is an evolving technique and limited data is available for MR targeted biopsies and no trial has compared MRI- targeted prostate biopsies with TRUS guided biopsies [4]. Robust scientific evidence from multi-centre randomised trials is required before the introduction of MRI/US fusion technique in routine urology practice. It will particularly be a useful option for men with suspected PCa and elevated PSA levels but previous negative biopsy.

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