Editorial

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Diffusion Tensor Imaging: The High-Resolution Image of Functionality in the Central Nervous System

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The *International Neurourology Journal* (INJ) has always been the leading journal in presenting advanced neurological investigations in the field of urology. The current issue is no exception, as we present a vast array of studies investigating urology with a neurological focus [1-3]. One major investigative modality recently gaining popularity in neurourological investigations is diffusion tensor imaging (DTI). The INJ has presented several studies utilizing DTI in the past [4-6].

In the current issue, Jang et al. [1] presents the study of lower urinary tract changes affecting central nervous system (CNS) white matter integrity by assessing white matter tracts in magnetic resonance (MR) DTI. In general, advances in neurological, especially CNS investigations attempt to marry functionality with imaging. On one hand surface techniques, beginning with electric encephalography, have developed to incorporate more topographic understandings as it evolved to magnetic encephalography (MEG), and most recently rubidium based optically pumped magentometers that could replace helium based MEG to light weight room temperature sensors [7]. On the other end of the spectrum, brain imaging methods, which had barely scraped the surface with computed tomography-based technologies, ranging from contrast methods to angiographies, had found a bloom in MR imaging techniques, which not only were able to elicit blunt contrasts between soft tissue densities, but owing to its magnetic spin based technology, could also be modified and tweaked to incorporate signals, activities, as well as tissue level structural analysis. While signal based evidence has shown much accolade with functional MR techniques (fMRI), the latter part is what DTI is capable of representing [6].

While it is difficult to explain the concept of DTI in simple terms, without egregiously abusing science, one can say that tensors, pertaining to MR imagines, are the manipulation of the electromagnetic field vectors and the substrate qualities of directionality into a mathematical expression [4,8]. Thus, diffusion in the context of MR, meaning the diffusion of water molecules given time, can describe the vector path within the tissue, and its minute path is not equal but dependent on tissue structure, resulting in differential anisotropy which could then be represented as an image. Water diffusion in tissues is highly sensitive to differences in the microstructural architecture of cellular membranes. Increases in the average spacing between membrane layers will increase the apparent diffusivity, whereas smaller spaces will lead to lower apparent diffusivities. This sensitivity makes DTI a powerful method for detecting microscopic differences in tissue properties [8].

As such, in the bluntest language, DTI is able to describe water dependent tissue microstructure based on direction. Since, one of the tenets of neurology as stated by the great Donald Hebb is that "neurons which fires together wires together," *structure*, especially in the microstructural level, *represents function* [9]. And as such, investigative methodologies that can highlight the appropriate structures also may suggest functionality. This is the fundamental difference of the image based 'bottoms up' approach, in contrast to the surface topographic studies which has its own layered history based upon dynamic neurophysics to elucidate the electromagnetic signals, and then formulate a topographic reconstruction between known structures, viz a viz, a 'top down' approach.

The current approach is particularly meaningful, as previous functional studies primarily focused the approach of highlighting the gross active brain regions via fMRI [6]. Recent advances in machine learning can also be used to further utilize these approaches by connecting different tensors of data from alternate modalities to better understand neurological activity in voiding [10]. Optogenetically modified neurologic manipulation is another venue that was unavailable to previous ages in investigating voiding neurology [11,12]. With these recent advances in varied but differing sources of information, the delineation between function and image of the CNS become blurred and we are provided with a higher resolution of understanding the true nature of changes in voiding symptoms. Perhaps, it is much fitting that the study by Jang et al. [1] returns back to the basic of neurourology, to reassess with the most recent advances in science the age old syndrome of "prostatitism," and to reevaluate what is going on beyond the "lower urinary tract." Furthermore, in the future, the cross referencing and combination of these novel biosignals may provide an exponentially more in-depth insight into the workings of our brain.

- **Conflict of Interest:** No potential conflict of interest relevant to this article was reported.

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