THE VALUE OF MR IMAGING AND DWI IN DIAGNOSIS OF PROSTATE CANCER AT 3 TESLA

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ABSTRACT

Prostate cancer is one of the most common cancers in men, the second cause of cancer-related death in men and the global burden of this disease is rising [1][2]. It is said that one in six men will develop prostate cancer in his lifetime. Early accurate tumor detection, accurate diagnosis, localization and staging of the disease can improve cancer survival and reduce treatment costs. Although unrestricted use of serum prostate-specific antigen (PSA) screening of healthy men has resulted in decreases in cancer-related mortality, this benefit has been accompanied by increased detection and treatment of many cancers bearing low metastatic potential. Imaging of prostate cancer has greatly improved since the introduction and evolution of multi-parametric magnetic resonance imaging (mp-MRI).

Retrospective article data suggest that multi-parametric Magnetic Resonance Imaging, which includes all the MRI technique available in current century like Diffusion-Weighted Imaging (DWI), Intravoxel Incoherent Motion Diffusion-Weighted Imaging(IVIM-DWI), Susceptibility weighted imaging (SWI), Perfusion weighted imaging(PWI), give an added importance in the prostate cancer detection, localization, local staging, diagnosis and treatment. The aim of the literature is threefold: an introduction for those who are new to the field, a synopsis for those working in the field, and a reference for those searching for literature on a specific application.

Objective: The main purpose of this article is to review the many evolving facets of MRI in the evaluation, detection, and diagnosis of prostate cancer. We will discuss the roles of MRI, DWI, IVIM-DWI, SWI, PWI, and DTI in detection, staging, treatment planning, and surveillance of prostate cancer.

Methods: We performed a systematic and retrospective review of literature about the role of magnetic resonance imaging (MRI) and its related technique like DWI, IVIM-DWI, SWI, PWI, etc. Different online databases were searched for the retrospective article to enlighten more about the emphasis of MRI and its appliances on diagnosis and treatment of prostate cancer.

Conclusion: MRI and its appliances can help detect, localize and diagnosis regions that may represent clinically significant prostate cancer. MRI can also be used to guide various prostate cancer treatments depending upon the gravity of the disease. An experienced radiologist and appropriately powered MRI scanner are essential to collect precise data about the case. MRI in the hands of an experienced uroradiology team is rising as a beneficial tool in the diagnosis and treatment of prostate cancer however this technology is still in its infancy and requires further evaluation. At present, MRI of the prostate is not debatable by Medicare.

Keywords: Diffusion-Weighted Imaging (DWI), Intravoxel Incoherent Motion Diffusion-Weighted Imaging(IVIM-DWI), Susceptibility weighted imaging (SWI),), Perfusion weighted imaging(PWI), Transrectal ultrasound (TRUS), dynamic contrastenhanced imaging (DCEI), Magnetic resonance imaging (MRI), prostate-specific antigen (PSA), Apparent Diffusion Coefficient(ADC)

INTRODUCTION

Prostate cancer is one of the most common cancers in men and its incidence continues to emerge in many countries like the united states, Australia, etc. [2][3][4]. Although it's a very high occurrence, however, only a few (2-4%) number of men will face death due to the disease. A necessary but elusive goal is that we still need the ability to prospectively identify the lethal cancers in a given population of men. Much more effort is now dedicated to this demanding need, especially with increasing appreciation of prostate cancer's over-diagnosis and over-treatment. The best- perceived hazard factors for the development of prostate cancer are old age, family history, ethnic origin, testosterone, genetic factors and environment [5]. One alike probable environmental factor which has gained a tremendous deal of recent scrutiny is the development of chronic inflammation in the prostate due to a number of potential causes counting infections, dietary factors, hormonal changes and/or other unknown environmental exposures [5]. The exact components of the progression of the prostate gland into cancer are not well differentiated. The presentation of serum PSA testing, in the so-called "PSA era" drive to a momentous increase in the prevalence of the disease and has been cursed for contributing to the over-diagnosis situation; while a positive PSA test signals an increased risk for prostate cancer, its low specificity and the related risk for superfluous intervention such as biopsy and conclusively prostatectomies result in a classic screening dilemma [10].

Transrectal ultrasound (TRUS)-guided biopsies sampling 6-12 cores, 1-2 for each sextant, has been the diagnostic measure for prostate cancer for many years. This methodical approach has provided a simple, comparatively easy, urology office-based test. The ultrasound images provide excellent instruction to the physician as to the gland size and boundaries but limited knowledge regarding internal glandular tissue and little or no structure on focal lesions. The prostate tissue samples are obtained in a directed way via a needle

aimed through the rectum to optimize the ability to sample the peripheral zone. Many areas, particularly the anterior gland, frequently are not sampled during TRUS biopsy. The method also has a possible risk of post-biopsy infection (rates 4-10%) and suffers from an inability to detect and diagnose clinically significant cancers. Magnetic resonance imaging (MRI) is accepted as one of the best imaging modalities for detecting and staging prostate cancer due to the accomplished anatomical images of the gland that it yields. Generally, T2-weighted imaging (T2WI) has been used for this purpose. However, the diagnostic efficiency of conventional T2WI is not adequate, and lately the use of functional methods, such as dynamic contrastenhanced imaging (DCEI), diffusion-weighted imaging (DWI), and spectroscopic imaging, have been recommended as an adjunct to conventional imaging. Several studies have demonstrated the feasibility of these functional methods using 1.5 T MRI in the human prostate [7][8][9].

The Role of MRI in Prostate Cancer:

Role of MRI in Guiding Prostate Detection and Biopsy:

The dominant advance in prostate MR has been the acknowledged and now widespread practice of combining multiple MR parameters for an overall anatomical and functional assessment of the prostate gland tissues. The multiparametric prostate MRI (mpMRI) exam is generally executed as a combination of T1-weighted imaging, T2-weighted imaging, diffusion-weighted imaging, and dynamic contrast-enhanced imaging [14]. Some hubs will include MR spectroscopy (MRSI), which can be very useful in adding a metabolic assessment [15] [16], though it is not currently listed as a prerequisite for prostate exams in a recent European consensus paper on prostate MRI methodology [17]. MpMRI with either 1.5 or 3.0 Tesla magnets and with or without endorectal coil is now favored and recommended the approach to all men presenting for prostate imaging. The use of an endorectal coil is an alternative and a subject of some debate [18] [19]. In recent years it has been shown that prostate MR imaging at 3T is feasible with sufficient image quality, even without using an endorectal coil [20]. The recent European consensus does not list the use of endorectal as an essential requirement of MpMRI. However, endorectal coils do add to the accessible signal-to-noise ratio, which can be applied to gain higher spatial detail and contrast [21].

A prostate cancer diagnosis is primarily based on prostate-specific antigen (PSA) screening and transrectal ultrasound (TRUS)-guided prostate biopsy. Nonetheless, PSA has small specificity because benign conditions can purpose elevated PSA. Thus, expanded PSA is not tantamount to a tumor, and normal PSA does not exclude a tumor [11] [12]. Because periodic TRUS biopsy is systemic, non-targeted, and conducted toward the tangential gland, some tumors can be missed, particularly those in the anterior prostate. TRUS biopsy has a negative predictive value (NPV) of 70–80% [13].

MRI has a specific value in identifying occult tumors in anatomic regions of the prostate that are not befittingly sampled during systematic sextant biopsy, such as the detection of tumors within the anterior zone, which may be inefficiently sampled on systematic biopsies. Men who are found on pre-biopsy MRI to have an anterior lesion could then be selected for anterior samplings in addition to TRUS 12-core biopsy.

Prostate MRI with MRI-directed biopsy is progressively regarded as a beneficial tool for refining risk status for clinically essential prostate cancer. Multiparametric MRI-directed biopsy is more responsive than systematic TRUS-guided techniques for detecting clinically momentous prostate cancers and, importantly, for reducing the number of insignificant cancers diagnosed. However, there is no consensus on the pertinent selection of men for MRI before the prostate biopsy, and this is a field in evolution. A few institutions, including those of most of the authors and editors of this topic, all men who have an approach to it undergo prostate MRI with MRI-directed biopsy, if convenient before planned TRUS biopsy.

There is increasing enthusiasm in using MRI before performing a biopsy in patients with elevated PSA. Potentially, the purpose of MRI before biopsy in men with elevated PSA levels could analyze patients who desire a biopsy because of significant cancer identified on MRI or those who only desire observation and thus can avert a biopsy. This may be of peculiar potential assistance in patients with only mildly elevated PSA, which can be due to a cause other than prostate cancer, such as benign prostatic hyperplasia (BPH) and chronic prostatitis. Multiparametric MRI before biopsy in men with questionable prostate cancer is currently being achieved in a few centers. Further investigation is needed to regulate the accuracy of MRI in this setting, establish how it fluctuates patient outcomes, and determine the potential cost-benefit of such an approach. Furthermore, the evidence is still required to justify the role of MRI as a replacement for TRUS biopsy. The NPV of MRI in the screening population is still unknown.

Diffusion weighted imaging (DWI):

Diffusion-weighted imaging is a process of gesture contrast generation based on the differences in Brownian motion. DWI is a method to evaluate the molecular function and micro-architecture of the human body. DWI signal contrast can be quantified by apparent diffusion coefficient maps and it acts as a tool for treatment response evaluation and assessment of disease progression. The ability to detect and quantify the anisotropy of diffusion leads to a new paradigm called diffusion tensor imaging (DTI). DTI is an apparatus for the assessment of the organs with an exceedingly organized fiber structure. DWI designs an integral part of modern state-of-art magnetic resonance imaging and is indispensable in neuroimaging and oncology. DWI is a field that has been undergoing rapid technical evolution and its applications are increasing every day. This review article provides insights into the evolution of DWI as a new imaging paradigm and provides a summary of the current role of DWI in various disease processes [6].

Generally, 60%-70% of the human body is composed of water. Diffusion is the random Brownian motion of the molecules guided by thermal energy. In a perfectly homogenous medium diffusion is random and isotropic; i.e., equal probability in all directions. But in a complex environment of the human body, water is divided between cells and extracellular compartments. Different tissues of the human body have a characteristic cellular architecture and proportions of intra and extracellular compartments and hence have characteristic diffusion properties. The relative proportion of the water distribution between these compartments is affected by the pathologic processes. For example, in high-grade malignancies and acutely infarcted tissues, the intracellular proportion is increased, so the diffusion becomes relatively more restricted.

Diffusion-weighted imaging contributes to qualitative and quantitative knowledge about diffusion properties. It adds a new dimension to the magnetic resonance imaging (MRI) examinations by adding functional information to the largely anatomical information gathered by the conventional sequences. Water diffusion is anisotropic in brain white matter because of axon membranes restraint molecular movement perpendicular to the fibers. Diffusion tensor imaging (DTI) accomplished this property to produce micro-architectural specialty of white matter tracts and implements information about white matter integrity.

Apparent Diffusion Coefficient(ADC):

An apparent diffusion coefficient (ADC) image, or an ADC map, is an MRI image that more precisely shows diffusion than accustomed DWI, by exterminating the T2 weighting that is otherwise inherent to conventional DWI [29]. ADC imaging does so by obtaining various conventional DWI images with diverse amounts of DWI weighting, and the variation in signal is proportionate to the rate of diffusion. Antithetical to DWI images, the conventional grayscale of ADC images is to describe a smaller magnitude of diffusion as darker [30].

Advantages of DWI:

DWI yields qualitative and quantitative information that provides a unique insight into tumor characteristics, and there is growing evidence for its use in the assessment of the patient with cancer. Some of them are as follows:

1. **Tumor Detection**

   Tumors are periodically more cellular than the tissue from which they originate and thus appear to be of relatively high signal intensity (restricted diffusion) at DWI. DWI is being appealed for the disclosure of liver metastases. In the liver, low b-value images (e.g., b = 50–150 s/mm2) that overcome the high-signal flow from the hepatic vessels, resulting in black blood images, have been discovered to be useful for lesion detection [22] [23].

2. **Tumor Characterization**

   Tumors contrast in their cellularity, and this difference may echo their histologic composition and biologic aggressiveness. The use of DWI for tumor characterization was first shown in brain tumors. To characterize lesions in the liver using DWI, b values ranging between 0 and 500 s/mm2 are appropriate [23]. Qualitative visual assessment can help to distinguish cystic from solid lesions. However, it is often difficult to distinguish different types of solid lesions from one another in the liver by visual assessment alone.

3. **Distinguishing Tumors from Nontumors**

   In prostate cancer, differentiating tumors from other causes of a low-signal-intensity lesion in the prostate gland is difficult on conventional T2-weighted MRI. Recently, DWI has demonstrated the potential for tumor identification [24]. The normal central gland of the prostate has a lower ADC than the peripheral zone [24]. Prostate cancers, which emerge as low-signal-intensity centers on ADC maps, typically show below ADC values than the peripheral zone and the transitional zone and central gland.

[24]. However, there is a meaningful extension in the ADC values of prostate cancer and benign prostate changes.

4. **Monitoring Treatment Response**

There is increasing investment in the administration of DWI for detecting tumor response [25]. Effective anticancer treatment results in tumor lysis, loss of cell membrane integrity, enhanced extracellular space, and, therefore, an improvement in water diffusion. However, this plot does not acknowledge the enrichment of intravascular perfusion to the diffusion measurement, which may be extraordinary in a tumor [26]. Hence, therapies that are targeted against tumor vasculature may also occur in a decrease in the ADC, especially when the DW images are obtained utilizing low b values, which are susceptible to vascular perfusion effects [27].

5. **Whole-Body Imaging**

Whole-body DWI is a latterly advanced application of DWI that, as previously explained, is performed utilizing a STIR EPI diffusion-weighted technique with a high b value of 1,000 s/mm2 for background suppression. By performing imaging at various stations in the body, a composite picture of the whole body can be composed. The images are concocted using maximum intensity projection and are usually visualized using a reversed black-and-white grayscale. Signals from healthy tissue such as blood vessels, fat, muscle, and bowel are suppressed. However, other normal compositions such as the spleen, prostate, testes, ovaries, endometrium, and spinal cord remain visible [28].

Disadvantages of DWI:

One of the most prominent challenges to the widespread enactment of DWI in the body for tumor assessment is the absence of standardization. The techniques employed to acquire DW images, including the choice of b values, alter considerably. Consequently, significant differences in the ADC preferences of similar diseases have been reported using different techniques. Apparently, future standardization of protocols (e.g., type of sequence, number of motion-probing gradient directions, b values, and TRs and TEs) for both image retrieval and data analysis beyond imaging platforms is critical.

Intravoxel Incoherent Motion Diffusion weighted imaging(IVIM-DWI):

IVIM is a philosophy and a method initially introduced and developed by Le Bihan to quantitatively evaluate all the infinitesimal translational movements that could furnish to the sign obtained with diffusion MRI. In this design, biological tissue comprises two distinct environments: molecular diffusion of water in the tissue (sometimes related to as 'true diffusion'), and microcirculation of blood in the capillary network (perfusion). The theory introduced by D. Le Bihan is that water flowing in capillaries (at the voxel level) mimics an aimless walk ("pseudo-diffusion") as long as the presumption that all directions are outlined in the capillaries is satisfied.

It is efficient for signal attenuation in diffusion MRI, which depends on the velocity of the circulating blood and the vascular architecture. Likewise, to molecular diffusion, the outcome of pseudo diffusion on the signal attenuation depends on the b value. However, the rate of signal attenuation occurring from pseudo

diffusion is typically an order of magnitude larger than molecular diffusion in tissues, so its relevant contribution to the diffusion-weighted MRI signal enhances significantly only at very low b values, allowing diffusion and perfusion effects to be separated.

Advantages of IVIM-DWI:

1. IVIM MRI was introduced to evaluate perfusion and generate maps of brain perfusion, for brain activation studies and clinical applications.

2. Modern work has proven the efficacy of the IVIM concept from fMRI, with an improvement in the IVIM perfusion parameters in brain activated regions, and the potential of the approach to aid in our understanding of the different vascular contributions to the fMRI signal [31].

3. IVIM MRI has further been utilized in the context of fMRI in a negative way.

4. IVIM MRI has lately undergone a remarkable revival for applications not in the brain, but throughout the body as well. IVIM MRI is currently being used in kidneys, heart as well as livers applications.

Disadvantages of IVIM-DWI:

IVIM imaging has differential responsiveness to vessel types, according to the extent of motion sensitization (b values) which are utilized.

The signal from large vessels with accelerated flow disappears suddenly with very low b values, while smaller vessels with the slower flow might still contribute to the IVIM signal obtained with b values larger than 200 s/mm^2. It has also been noted that the parameter f, often mentioned to perfusion fraction, is susceptible to differential spin-spin leisure rates in the two model compartments (blood/tissue) and can thus be overestimated in highly-perfused tissue [32].

Susceptibility weighted imaging(SWI):

Susceptibility weighted imaging (SWI), formerly called BOLD venographic imaging, is an MRI sequence that is exquisitely sympathetic to venous blood, hemorrhage and iron storage. SWI practices a fully flow counterbalanced, long echo, gradient recalled echo (GRE) pulse progression to procure images. This method utilizes the susceptibility differences between tissues and uses the phase image to identify these differences. The magnitude and phase data are consolidated to provide an intensified variation magnitude image. The imaging of venous blood with SWI is a blood-oxygen-level-dependent (BOLD) technique which is why it was relegated to as BOLD venography. Due to its sensitivity to venous blood SWI is commonly used in traumatic brain injuries (TBI) and for high-resolution brain venographies but has many other clinical applications.

Advantages of SWI:

SWI is most commonly used to detect small amounts of hemorrhage or calcium. Some of its advantages are in the following sectors:

1. Traumatic brain injury (TBI)

2. Stroke and hemorrhage

3. Sturge-Weber disease

4. Tumors

5. Multiple sclerosis

6. Vascular dementia and cerebral amyloid angiopathy (CAA)

7. Pneumocephalus

Disadvantages of SWI:

SWI sequences have some intrinsic disadvantages. Objectionable magnetic susceptibility references that cause artifacts occurring at air-tissue interfaces such as the areas contiguous to the temporal bone and sinuses limit the investigation of these regions. Also, the blooming artifact, a beneficial sign for detecting references of field inhomogeneity, may sometimes commence to extreme tissue signal cancellation and loss of anatomical borders [33].

Perfusion-Weighted Imaging:

Perfusion imaging utilizing MR is an evolving technology that has displayed a popular alternative to nuclear medicine perfusion techniques to examine cerebral hemodynamics and bloodstream. Perfusion is quantified in the duration of the flow rate (milliliters/min) normalized to the tissue mass (typically per 100 g brain tissue). Perfusion-weighted imaging is used in stroke to delineate normally perfused tissue from benign oligemia and infarct gist. It can also be used to manage the blood flow resources in patients with chronic cerebrovascular abnormalities (i.e., moyamoya disease) by means of a Diamox stress test. Perfusion-weighted imaging can effortlessly be combined with other MR techniques such as MR angiography to evaluate vessel patency, and DWI to evaluate the ischemic injury to brain parenchyma. There are 3 main procedures for perfusion MRI:

❖ **Dynamic susceptibility contrast (DSC)**: Gadolinium contrast is inoculated and accelerated reoccurred imaging (generally gradient-echo echo-planar T2 weighted) quantifies the susceptibility-induced signal loss [34].

❖ **Dynamic contrast enhanced (DCE):** Measuring shortening of the spin-lattice leisure (T1) produced by a gadolinium antithesis bolus [35].

❖ **Arterial spin labelling (ASL):** Magnetic labeling of arterial blood underneath the imaging slab, without the obligation of gadolinium contrast [36].

It can also be demonstrated that diffusion MRI models, such as intravoxel incoherent motion, also endeavor to obtain perfusion.

Advantages and Disadvantages:

Perfusion-weighted or hemodynamically weighted MR progressions were generated and then had application in the evaluation of hyperacute stroke. DSC techniques are the most popularly used method to estimate brain perfusion with MRI. The software to post-process these data is widely accessible and relatively straightforward to use. DSC-derived relative CBV is the most widely used and robust method to evaluate brain tumors. Some disadvantages of this technique include the challenge in ascertaining unquestionable

quantification, susceptibility artifacts (i.e., blood product, calcification, metal, air, and bone), and user confidence.

DCE techniques propose the user the ability to analyze the brain microvasculature from a different prospect from DSC MRI by conceding quantitative assessment of the blood-brain impediment and microvascular permeability. This can provide a further complete estimation of brain tumor angiogenesis. Some detriments of DCE MRI include complexity in concept acquisition and pharmacokinetic model postprocessing, user-dependence, and reduction of widely available and easy-to-use postprocessing software.

Techniques that practice exogenous contrast agents have some advantages over ASL. In general, DSC and, even more, DCE MR perfusion accomplish a substantially higher SNR that concedes imaging at a higher temporal and spatial resolution, e.g., DSC MR perfusion authorizes the visualization and quantification of the entire brain in less than a minute of acquisition time. Even though ASL could be enhanced with the use of high-quality and high range strength scanners, the overall SNR is still insufficient, which results in much longer scanning times, e.g., 8–10 minutes at 1.5 T or 4–5 minutes at 3 T [37].

Diffusion Tensor Imaging(DTI):

Diffusion tensor imaging is a magnetic resonance imaging procedure that empowers the measurement of the restricted diffusion of water in tissue in harmony to produce neural tract photographs instead of using this data singularly for the purpose of assigning variation or colors to pixels in a cross-sectional image. It also provides valuable structural knowledge about muscle including heart muscle as well as other tissues such as the prostate [38].

Diffusion tensor imaging (DTI) is significant when a tissue—such as the neural axons of white matter in the brain or muscle fibers in the heart—has an internal fibrous structure analogous to the anisotropy of some crystals. Water will then diffuse more rapidly in the direction aligned with the internal structure, and more slowly as it moves perpendicular to the preferred direction. This also suggests that the measured frequency of diffusion will diverge depending on the direction from which an observer is looking.

In DTI, each voxel has one or more combinations of parameters: a rate of diffusion and a favored direction of diffusion explained in terms of three-dimensional space for which that parameter is legitimate. The characteristics of each voxel of a single DTI image is habitually calculated by vector or tensor math from six or more distinct diffusion-weighted acquisitions, each obtained with a distinct orientation of the diffusion sensitizing gradients. In some courses, hundreds of measurements each constructing up a complete image are created to produce a single producing anticipated image data set. The more distinguished information content of a DTI voxel makes it remarkably sensitive to inferred pathology in the brain. In extension, the directional erudition can be appropriated at a higher level of structure to elect and follow neural tracts through the brain a manner called tractography.

Advantages of DTI:

❖ Able to pick up tears in white matter that MRI and CAT scans do not pick up.

❖ obtains more detailed information from MRI scans and allows us to obtain images of white matter.

❖ It can help doctors predict recovery times for concussion patients.

❖ It can help solve the mystery of concussions through its deeper and in depth scan of the brain.

❖ It provides a 3D visualization of neuronal pathways.

❖ DTI is an effective tool for comprehensive, noninvasive, functional anatomy mapping of the human brain.

Disadvantages of DTI:

❖ Diffusion images are sensitive to water diffusion that is in the order of 5-10 µm during the measurement time. If this happens, images are sometimes full of ghosting due to the water molecules encountering obstacles. In the white matter, some of these obstacles include protein filaments and cell membranes, all of which have strongly aligned structures.

❖ The low spatial resolution which means a lower amount of pixels so the images may come out blurry at times.

❖ extremely sensitive to motion and can cause misregistration if the patient moves. Because of this, DTI requires at least 7 tensor fittings.

❖ requires extensive computing power, man-hours, and expertise.

CONCLUSION

Magnetic resonance imaging has shown exceptional promise for the diagnostic performance-up of patients with multiple diseases and to facilitate treatment judgments as well as treatment monitoring. Overall, the MR techniques exhibited here drive to a tremendous expansion of knowledge that can be obtained during an MRI session in addition to conventional structural MRI and is unmistakably a great asset to shaping the final diagnosis or providing better differentials. It is foreseeable that numerous more technological improvements will occur in these areas that may additionally help improve diagnosis and treatment. It is believed that, with this review, a better perception of these exciting methods has been implemented, making the reader more aware of their potential strengths and weaknesses.

mpMRI has appeared as a very beneficial instrument in the diagnosis and treatment of prostate cancer. Although it is an expensive technology, we consider it can confer significant cost savings by reducing the number of prostate biopsies conducted, as well as improving patient care by aiding more rapid and accurate diagnosis [39]. There can be developments in the surgical margin rate, which also reduces the risk of future recurrences and the necessity for adjuvant or salvage radiotherapy. Additional investigation is expected to circumscribe the optimal techniques, indications, and interpretation of mpMRI [40].

DWI is an important imaging device that provides unique information associated with tumor cellularity and the integrity of the cellular membrane. The technique can be implemented widely for tumor detection and tumor characterization and for the monitoring of acknowledgment of treatment. In addition, DWI resembles to have the intelligence to predict treatment response to chemotherapy and radiation treatment. Whole-body DWI is a fresh development that shows substantial commitment for tumor detection but necessitates further evaluation. There are, however, major challenges to the widespread enactment of DWI,

among which are standardization of data acquisition and analysis. Nevertheless, because DWI is agile to perform, DWI can be consolidated into conventional clinical protocols to be widely evaluated.

One of the most prominent challenges to widespread adoption of DWI in the body for tumor assessment is the absence of standardization. The techniques implemented to acquire DW images, including the selection of b values, vary considerably. Consequently, essential differences in the ADC values of related diseases have been notified using different techniques. Future standardization of protocols (e.g., type of sequence, number of motion-probing gradient directions, b values, and TRs and TEs) for both image acquisition and data analysis across imaging platforms is important.

Current software tools that are accessible for quantitative analysis on most profitable platforms are fairly basic and do not permit more complex processing. DW images are inherently vociferous, and the ability to produce noise filtration may be helpful. Image registration can also help to reduce errors in ADC calculations and further enhance the quality of the ADC data. Besides, other metrics, such as fractional anisotropy and perfusion fraction, should be reviewed in imaging the patient with cancer. The development and availability of software that allows more sophisticated data analysis would be welcomed.

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