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VALUE OF DIFFUSION WEIGHTED IMAGING IN CARCINOMA PROSTATE.

Radio-Diagnosis

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ABSTRACT

Objective: The aim of the study was to determine if combining T2-weighted (T2W) imaging with diffusion-weighted (DW) imaging would lead to better detection of prostate cancer compared to T2W imaging alone.**Methods:** The study involved 60 participants, 37 with prostate cancer and 23 without, undergoing MR imaging using a 1.5-T super conducting magnet. The participants received both T2W and DW imaging using parallel imaging, and their images were independently evaluated by three readers to determine prostate cancer detectability. The effectiveness of T2W imaging alone and T2W imaging with DW imaging was compared using receiver operating characteristic analysis. **Results:** The results showed that the average receiver operating characteristic curve for T2W imaging alone was 0.87 and increased to 0.93 when combined with DW imaging. The analysis also showed a statistically significant improvement in tumor detection with the addition of DW imaging to T2W imaging, as indicated by a P value of 0.0468. **Conclusions:** The conclusion of the study is that the use of DW imaging in addition to T2W imaging leads to improved detection of prostate cancer.

KEYWORDS

Magnetic Resonance Imaging, Prostate Cancer, Diffusion- Weighted Imaging, Parallel Imaging

INTRODUCTION:

The latest global cancer incidence estimates reveal that prostate cancer is the third most frequently occurring cancer among men, with an estimated half a million new cases each year.[1] In Japan, the mortality rate from prostate cancer is lower than in Western countries, but it is increasing rapidly. Early detection of prostate cancer is crucial for reducing its mortality.[1,2]

Recent studies have shown the ability to detect prostate cancer through magnetic resonance imaging (MRI).[3,4] On T2W MRI, prostate cancer appears as regions with decreased signal intensity compared to normal peripheral zone tissue, due to increased cell density and a loss of prostatic ducts.[4] However, this finding is not specific, as other conditions such as prostatitis or hyperplasia can also result in low signal intensity on T2W MRI. [5-8] Detection of prostate cancer in the transition zone, which affects up to 30% of all prostate cancer cases, is also challenging as this area is the origin of benign prostatic hyperplasia and can have a diverse appearance.

Recently, diffusion-weighted (DW) imaging has been used to visualize abdominal and pelvic [9] lesions such as liver[10-11], renal[12], and ovarian tumors.[13-14] Some initial studies[15] have shown that DW imaging can distinguish malignant neoplasms from benign prostate tissue due to a significant difference in the apparent diffusion coefficient value. However, these studies did not assess the ability to detect human prostate cancer.

The study aimed to evaluate the detectability of prostate cancer using T2W imaging combined with DW imaging compared to T2W imaging alone.

MATERIALS AND METHODS:

This study was conducted retrospectively at a single institution between January and November 2021. 124 patients with elevated prostate specific antigen levels, but no prior treatment for prostate cancer, underwent MR examination including DW imaging. Of the 124 patients, 60 had a histopathological diagnosis confirmed through surgery or biopsy of 10 sites. The remaining 64 patients were excluded from the study: 30 patients were scheduled for biopsy but did not undergo it within the study period, and the other 34 patients did not undergo biopsy for various reasons (deterioration in health, multiple metastatic disease, desire to be followed without biopsy, or desire to consult another hospital). 62% (37 of 60) of the patients had prostate cancer and underwent biopsy or surgery within 6 months of the MR examination. The average patient age was 71 years with a range of 54 to 82 years and the average prostate specific antigen value was 21.8 ng/mL (range: 4.5 to 130 ng/mL). Informed consent was obtained from all patients before MR imaging.

Statistical Analysis:

Receiver operating characteristic analysis was performed to compare the results of routine T2W imaging and T2W imaging combined with DW imaging (rating scale range: 1-5). The area under the receiver operating characteristic curve (Az) was calculated for each reader and MR sequence. The statistical significance ($P < 0.05$) of differences in the Az was determined using the unpaired Student's t-test. The receiver operating characteristic curves were estimated using the ROCKIT 0.9B beta version program. Sensitivity, specificity, positive predictive value, and negative predictive value were also calculated.

RESULT :

The results of the sensitivity and specificity for the three readers when using T2W and combined T2W/DW imaging are summarized in Table 1. The results show that all readers had improved sensitivity and specificity when using both T2W and DW imaging compared to just T2W imaging.

The Az values for the 3 readers for T2W imaging and T2W imaging combined with DW imaging were 0.85 and 0.93, 0.88 and 0.96, and 0.87 and 0.89, respectively. The average Az value for T2W imaging and T2W/DW imaging was 0.87 and 0.93 respectively, as shown in Figure 1. The receiver operating characteristic analysis indicated that adding DW imaging to T2W imaging significantly improved the diagnostic accuracy ($P = 0.0468$). No significant differences were found in the diagnostic accuracy among the 3 readers ($P > 0.05$).

Diffusion-weighted imaging effectively identified prostate cancer as hyperintense focal areas (as seen in Figures 2). The combination of T2W imaging with DW imaging led to a diagnosis of cancer in 96 (86%) out of 111 cases, compared to 87 (78%) out of 111 cases diagnosed using T2W imaging alone. DW imaging also helped detect prostate cancer in the transition zone, which can be difficult to distinguish from benign conditions such as benign prostatic hyperplasia using T2W imaging alone (as shown in Figure 2). Results from radical prostatectomy specimens showed that 8 out of 18 patients had cancer in the transition zone, and DW imaging depicted the cancer as hyperintense in 5 (63%) of these 8 patients. In contrast, T2W imaging alone was able to clearly identify cancer in the transition zone in only 1 (13%) of the 8 patients, and only in this case did the cancer involve both the peripheral zone and the transition zone.

Diffusion-weighted imaging was able to distinguish between prostate cancer and certain hypointense lesions that can mimic cancer on T2W imaging (as shown in Figure 3). Out of the total 180 cases reviewed by the three readers, there were 16 false-positive diagnoses using T2W imaging alone, compared to 11 false-positive diagnoses using T2W and DW imaging. All readers also had a higher negative predictive value when using T2W and DW imaging compared to just T2W imaging. The average negative predictive values for T2W imaging alone and T2W/DW imaging were 69% and 79% respectively.

DISCUSSION:

Magnetic resonance imaging (MRI) is frequently utilized for diagnosing prostate conditions. However, its conventional T2W imaging technique has limitations in accurately distinguishing prostate cancer from benign prostatic hyperplasia, resulting in good sensitivity (78%–83%) but low specificity (50%–55%). To improve specificity, MR spectroscopy has been applied and has demonstrated high sensitivity (95%) and specificity (91%) in detecting and localizing prostate cancer. Despite its effectiveness, MR spectroscopy is not a routine procedure in commercial MR systems. Dynamic contrast-enhanced MRI has also been used for tumor detection with a reported sensitivity of 74% and specificity of 81%. However, these values are lower compared to MR spectroscopy and are not significantly different from conventional T2W images.

The use of Diffusion-weighted imaging (DW imaging) is an effective way to identify prostate cancer. The many tightly packed glandular elements of prostate cancer cause the apparent diffusion coefficient values to be significantly lower than in normal prostate tissue, which results in better differentiation between cancerous and non-cancerous tissue. DW imaging can be performed on most MR scanners without additional software.

This study applied diffusion-weighted imaging with parallel imaging and a high b-value (b=1000) for the detection of prostate cancer, a novel approach. DW imaging showed prostate cancer as hyperintense focal lesions with improved contrast compared to T2W imaging, allowing for differentiation between cancerous and non-cancerous lesions with greater confidence.

This is the first clinical study to use DW imaging with parallel imaging and a high b-value (b=1000) for detecting prostate cancer. Results showed that prostate cancer appeared as a hyperintense focal lesion on DW imaging, providing greater contrast and differentiation compared to T2W imaging. DW imaging has the ability to detect prostate cancer not only in the peripheral zone but also in the transition zone (as seen in Fig. 2).

The capability of detecting cancer in the transition zone gives DW imaging a great advantage over conventional T2W imaging and MR spectroscopic imaging. Although there were differences in the patient populations, sensitivity (86%) and specificity (84%) on T2W imaging with DW imaging in our study without an endorectal coil were higher than those of former studies (sensitivity: 74%–83%, specificity: 50%–81%) with an endorectal coil[4–9] and a dynamic study.

In the present study, the apparent diffusion coefficient value was not quantified due to the use of a high b-value (b = 1000) that reduced the signal-to-noise ratio and hindered the ability to select an appropriate region of interest in correlation with the pathological specimen. This is typical for small lesions. To balance the signal-to-noise ratio and diffusion weighting, b-values of 400 to 500, as used in liver DW imaging, may be more suitable. Improving the signal-to-noise ratio can be achieved by increased averaging and/or using an endorectal coil modified for echo planar imaging.

The most appropriate b value for DW imaging of the prostate is still to be established. Further studies with various b-values, larger patient populations, and imaging sequence modifications are needed.

CONCLUSION :

In conclusion, the results highlight the potential usefulness of prostatic DW imaging in clinical practice. DW imaging combined with T2W imaging showed a higher rate of detecting prostate cancer.

Table1:Diagnostic Performance of T2 W Imaging Aloneand Combined T2 W and D W Imaging for the Detection of Prostate Cancer T2W imaging alone

	Sensitivity(%)	Specificity(%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Az
Reader1	76	74	82	65	0.85
Reader2	73	83	87	66	0.88
Reader3	86	74	84	77	0.87
Mean	78	77	84	69	0.87

Combined T2W
And DW imaging

Figures and legends:

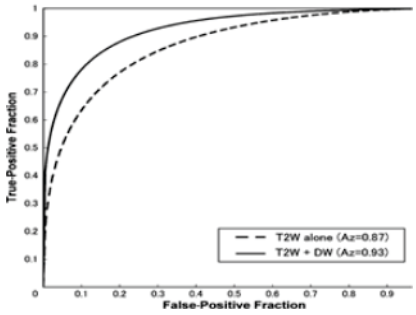

Figure 1. The study compared the performance of T2W imaging alone and T2W imaging combined with DW imaging for detecting prostate cancer using mean receiver operating characteristic curves. The results showed that the mean area under the receiver operating characteristic curve was higher for the combined T2W and DW imaging (0.93) compared to T2W imaging alone (0.87). The difference between the two receiver operating characteristic curves was statistically significant, with a P value of 0.0468.

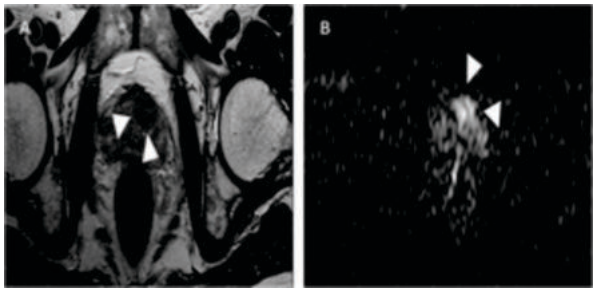

Figure 2. A 72-year-old man was diagnosed with prostate cancer. An axial T2-weighted image showed a 20mm diameter hypointense area in the left central gland, but it was difficult to distinguish from other benign lesions. An axial imaging diffusion-weighted image demonstrated a focal hyperintense lesion, which was later confirmed to be moderately differentiated adenocarcinoma after a radical prostatectomy.

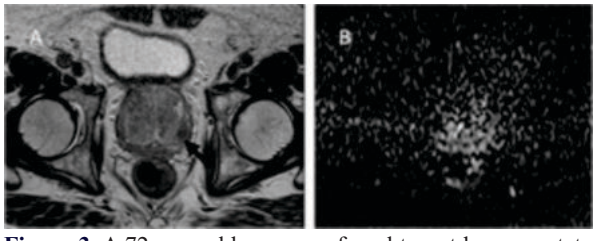

Figure 3. A 72-year-old man was found to not have prostate cancer. An axial T2-weighted image showed an enlarged prostatic gland due to benign prostatic hyperplasia and a small hypointense focus in the left peripheral zone. However, prostate cancer could not be ruled out based on this appearance. An axial diffusion-weighted image did not demonstrate any focal hyperintense lesions. Biopsies from 10 sites, including the left peripheral zone, did not reveal any signs of malignancy.

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